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TO CLINICAL RADIOLOGY AND
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RADIOLOGY

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Lymphangiograms: Their Diagnostic and Therapeutic Potential[1]

SIDNEY WALLACE, M.D.,[2] LAIRD JACKSON, M.D., BURTON SCHAFFER, M.D., JOHN GOULD, M.D., ROY R. GREENING, M.D., ARTHUR WEISS, M.D., and SIMON KRAMER, M.D.

LYMPHANGIOGRAPHY, the radiographic demonstration of the lymphatic system by intralymphatic injection of contrast material, has opened a new field of investigation. Earlier attempts at indirect lymphography were made by injection of radiopaque material into the subcutaneous tissue with uptake in the adjacent nodes (1). Direct injection into large palpable nodes, lymphadenography, was introduced by Carvalho in 1931 (6, 26, 31). Kinmonth in 1955 developed lymphangiography as a method of study of lymphedema of the lower extremities (20). Hreshchyshyn and Sheehan recently modified this approach (13). We have utilized the procedure with only minor variations to study the dynamics of the lymphatic system and the abnormalities in the nodes in various disease states. We have correlated our findings in man with those of animal investigations as summarized by Drinker, Yoffey, and Courtice (8, 29). Our investigation was initiated at Jefferson Medical College Hospital and later extended to include the group at Philadelphia General Hospital.

METHOD

The method of lymphangiography to be described here applies to both the upper and lower extremities. Half a milliliter (0.5 ml.) of a mixture containing equal parts of 0.5 per cent Evans blue dye and 1 per cent procaine hydrochloride is injected intradermally into the interdigital web space between the first and second or fourth and fifth digits of the extremity. The procaine hydrochloride is added to minimize the transitory pain which occurs when the dye is injected alone. The blue dye is selectively absorbed by the lymphatics, making them readily identifiable within fifteen to thirty minutes (Fig. 1). At that time, with aseptic technic, a small skin incision is made proximal to the injection site and a lymphatic conveying the blue dye is identified and isolated. An untied ligature is placed around the vessel proximally to obstruct and distend it temporarily (Fig. 2). A small, narrow-gauge needle (25 to 30 depending on lymphatic size), which has previously been fitted to a polyethylene tube, is then threaded into the vessel and secured in place by a ligature. Ethiodol, an ethyl ester of poppyseed oil containing 37 per cent iodine, is placed in a syringe connected by an adapter to the polyethylene tubing, and low and constant pressure is applied to the syringe by means of a "C-clamp" apparatus, which is manually driven (Fig. 3). The contrast material is thus slowly

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[2] National Cancer Institute Fellow.

Fig. 1. Evans blue dye injected in the 1st and 4th interdigital web space. The curvilinear marking on the ulnar aspect of the hand demonstrates a lymphatic.
Fig. 2. Isolation of a lymphatic.

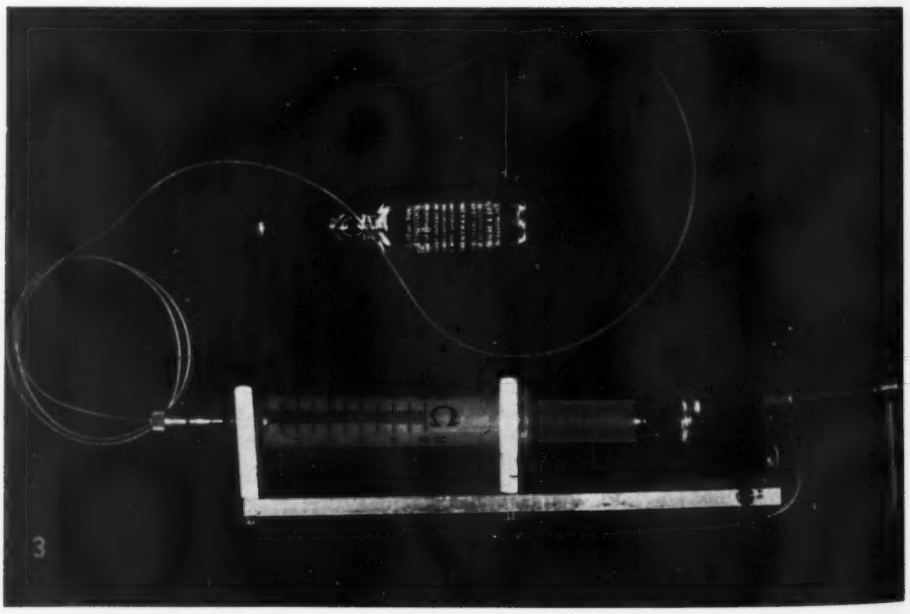

Fig. 3. Apparatus for constant low-pressure injection of contrast material.

forced into the lymphatic system. Best and most extensive visualization is achieved when injections are prolonged over a period of an hour and a half to two hours, at a rate of approximately 7 ml. per hour. Undue pressure may cause extravasation of the contrast material into the soft tissues of the extremity. We generally use 5 to 7 ml. of radiopaque material in the upper extremity and 10 to 15 ml. in the lower extremity, not exceeding a total of 25 ml. if both legs are injected. These amounts should be decreased for smaller persons or children in order to avoid forcing the oily material into the general circulation.

Roentgenograms are taken at the completion of the injection for best demonstration of the lymphatic channels. We have found that the patient must remain supine throughout the entire procedure for visualization of the thoracic duct. Injection in the feet will demonstrate the nodes in the inguinal, external iliac, common iliac, and para-aortic areas, as well as the thoracic duct and supraclavicular nodes. The axillary and supraclavicular nodes are seen after injection of the lymphatics of the hand. The contrast material leaves the vessels a few hours after the completion of the injection. The nodes are best seen on the twenty-four-hour films. Normally they may be demonstrable radiographically for approximately four weeks; some abnormal nodes, however, may be visible for as long as four to six months. Roentgenograms for the observation of changes during this period may be obtained without further injection.

CLINICAL MATERIAL

This report presents our results in the lymphangiographic study of 110 patients; 207 extremities were injected: 174 lower and 33 upper extremities. The lesions studied were as follows:

Carcinoma	54
Lymphoma	28
Edema	12
Infection	5
Other	11

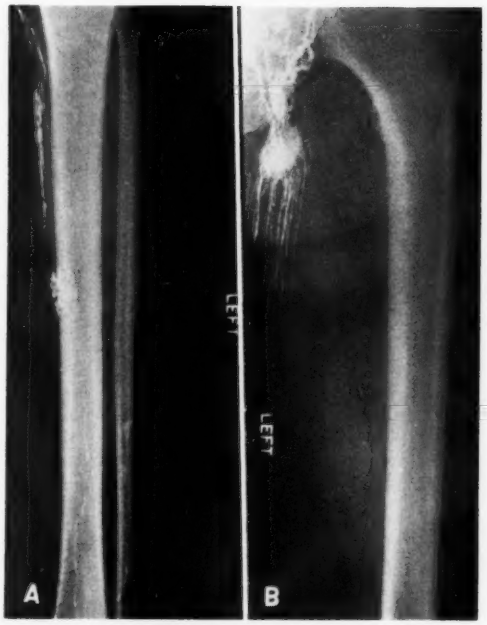

Fig. 4. Normal lymphatic distribution of the lower extremity. A. Both greater and lesser saphenous distribution demonstrated. B. Lymphatics paralleling greater saphenous vein in the thigh; femoral node is visualized.

RESULTS AND DISCUSSION

Normally, the lymphatics parallel the venous system throughout the body. In the lower extremities they follow the greater and lesser saphenous veins; in the upper extremities, the basilic and cephalic veins. One lymphatic in each extremity is cannulated and injected, producing adequate visualization of the nodal areas. In the entire lower limb, the lymphatics are of fine caliber (Fig. 4). As they enter the pelvis (Fig. 5, A) and continue through the para-aortic areas, they increase in size (Figs. 5, B, C, D). In the normal limb there is a separate lymphatic drainage for the medial and lateral aspect, with little intercommunication until the inguinal nodes are reached. At the upper level of the sacrum, there is a crossing over to the opposite side. The para-aortic lymphatics drain into the cisterna chyli at about L-2, where this continues on as the thoracic duct (Fig 6). The latter can be seen as it traverses the thoracic cavity up to the left subclavian

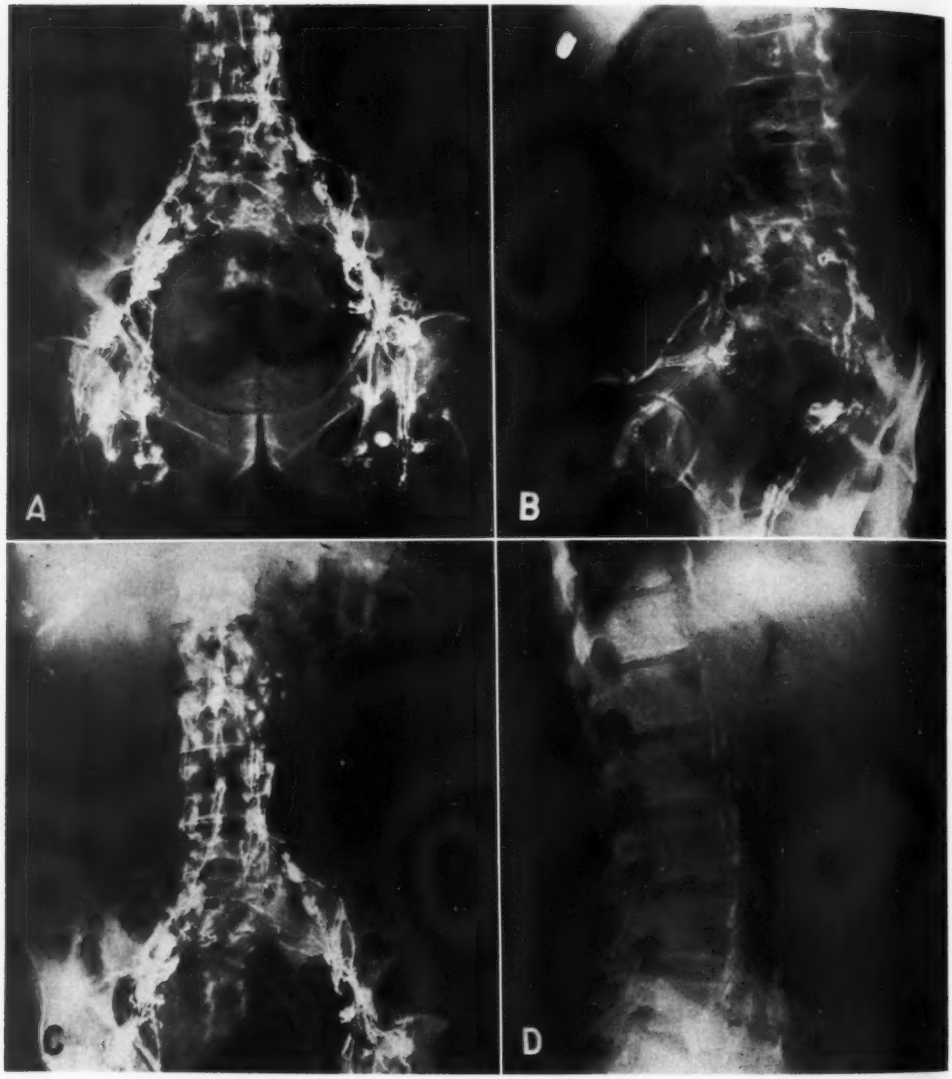

Fig. 5. Normal lymphatic distribution. A. Pelvis—inguinal, external, and common iliac areas: anteroposterior view. B. Pelvis—oblique view. C. Para-aortic lymphatics and nodes: anteroposterior view. D. Para-aortic lymphatics and nodes: lateral view.

vein. Occasionally an anomalous right thoracic duct is demonstrated. Generally some supraclavicular nodes reveal considerable uptake of the contrast medium.

The normal lymphatics of the upper extremities are, as a rule, finer than those of the lower limb (Fig. 7). The lymphatics which follow the basilic vein, traversing the inner aspect of the arm to the axillary nodes, are usually outlined. Here they branch as they continue through the axillary nodes, frequently going through the supraclavicular nodes, finally to reach the subclavian vein (Fig. 8).

Idiopathic Lymphedema: Congenital malformations of the lymphatics are thought to be the primary factor in the production of idiopathic lymphedema. Kinmonth studied 87 cases of idiopathic lymphedema by lymphangiography (21).

He described four primary types of abnormality. (*a*) Hypoplasia (55 per cent of all cases) was the most common finding. Here there were fewer lymphatics, which were usually larger in caliber than in normal patients. (*b*) Dilated or varicose channels (24 per cent) frequently were associated with dermal backflow, which

Fig. 6. The thoracic duct.

is the demonstration of many small collateral channels in the skin. These dilated vessels often drained into normal lymphatics without evidence of obstruction. Dilatation was occasionally associated with other vascular anomalies. (*c*) Aplasia of the lymphatics was found in 14 per cent of the cases. (*d*) Dermal backflow alone was present in 6 per cent. Kinmonth also postulated that clinical lymphedema may not be manifest in cases of lymphatic abnormality until there is superimposed trauma or infection with concomitant increase in tissue fluid.

One of the 2 cases of idiopathic lymphedema which we studied demonstrates the presence of dilatation and dermal backflow

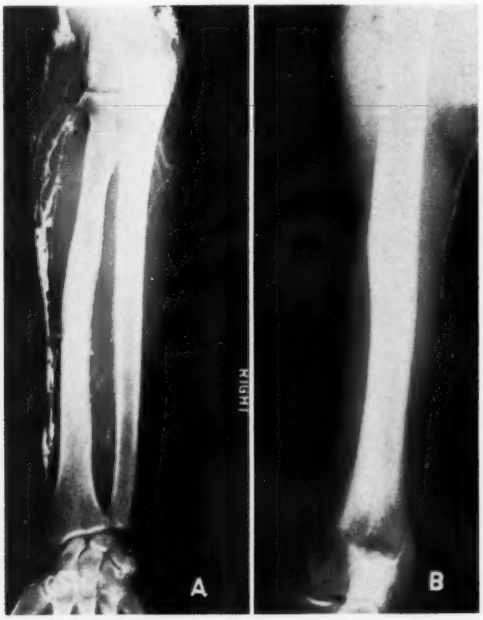

Fig. 7. Normal lymphatic distribution of the upper extremity. A. Radial and ulnar lymphatics were injected. B. Lymphatic chain in the brachium parallels the basilic vein distribution.

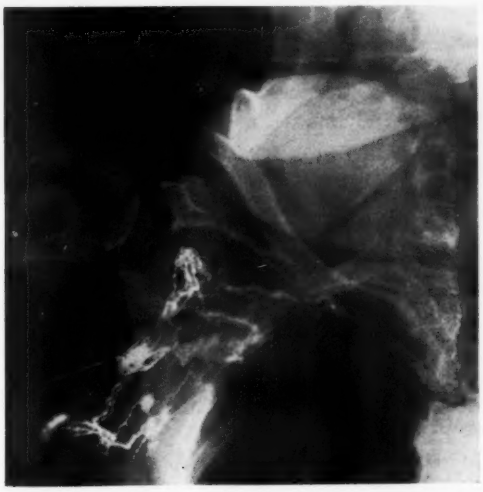

Fig. 8. Normal lymphatic distribution in the axilla. These vessels eventually drain into the subclavian vein.

(Fig. 9). Edema did not develop in this patient until the age of twenty-five, approximately six months after an injury to his lower leg. The second patient had idiopathic bilateral lymphedema; none

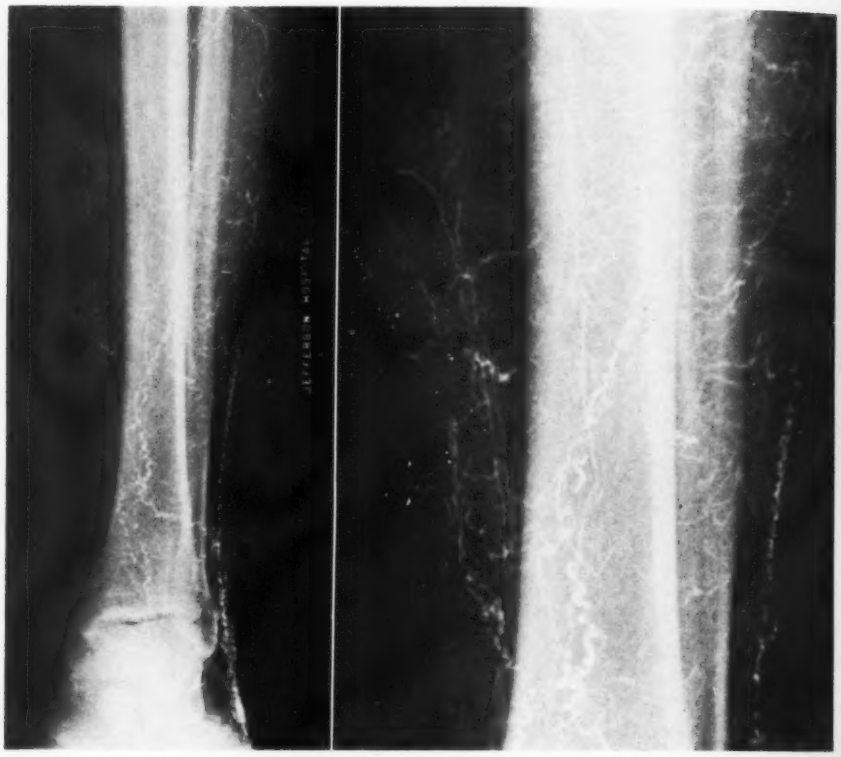

Fig. 9. Idiopathic lymphedema of the lower extremity. Dermal backflow is demonstrated.

of the abnormalities which Kinmonth described were found within the extremities themselves, but dilated channels were seen within the para-aortic area (Fig. 10). The alteration may therefore be in areas which were not demonstrated by Kinmonth.

Acquired Lymphedema and Lymphatic Obstruction: Acquired lymphedema has been studied extensively in animals but has been difficult to produce experimentally. Reichert (1926) divided the tissues of the thigh of a dog with the exception of the major blood vessels and the sciatic nerve, thereby cutting all lymphatics (25). Edema occurred, but subsided following regeneration of the lymphatics by the fourth to eighth day postoperatively. Drinker produced sclerosis of the lymphatics but edema failed to develop until not a single lymphatic trunk could be demonstrated in the extremity. The onset of edema was hastened by preliminary iliac node dissection. It appears, therefore, that marked damage to the lymphatic channels must occur before lymphedema will result.

Of the 3 cases of acquired lymphedema presented, one shows the appearance of dermal backflow as seen in some of the reported idiopathic cases (Fig. 11). This patient received radiation therapy to the leg (left) for a Kaposi's sarcoma. Subsequently edema developed, involving the left leg only. The lymphangiogram is similar to the one reproduced in Figure 9. Two other cases demonstrate lymphatic obstruction with edema due to a neoplasm, with the formation of collateral channels (Figs. 12 and 13). These channels appeared inadequate to handle the increase in tissue fluid. On the other hand, collateral channels may adequately compensate for lymphatic obstruction, in which event no

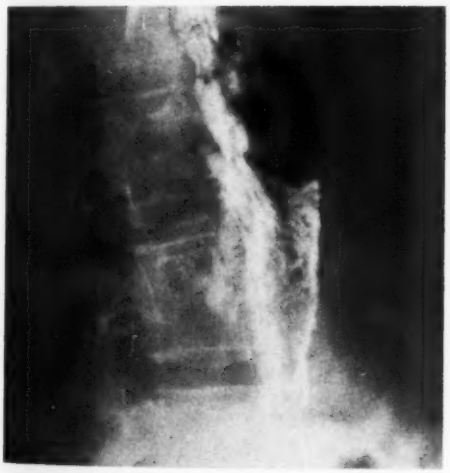

Fig. 10. Idiopathic lymphedema of both lower extremities. Congenital anomalous lymphatics in the retroperitoneal area are shown adjacent to the 4th lumbar vertebra.

edema will occur. This is shown in Figure 14, A with obstruction of lymph flow one year after an inguinal lymph-node dissection for metastatic carcinoma of the penis. In Figure 14, B, there is a similar pattern from pelvic Hodgkin's disease.

Distortion: Changes in the normal distribution of the lymphatic channels may be produced by adjacent masses. This is most frequently seen with pelvic neoplasms. Figure 15 presents a patient who was thought to have pelvic metastasis from carcinoma of the penis.

Normal Lymph Nodes: The lymph nodes are best evaluated by studying roentgenograms made twenty-four hours after injection of the contrast medium. The normal lymph node has a globular or kidney-shaped outline and measures approximately 1.5 cm. in maximum diameter. The margin is frequently interrupted by a slight indentation at the hilus (Fig. 16). The nodal architecture has a homogeneous reticular pattern. The inguinal nodes in adults commonly measure more than 1.5 cm., which we attribute to the frequency of low-grade inflammation in the lower extremity. Our method of injection outlines the skeletal (iliac, para-aortic or vertebral) nodes in contrast to the visceral (mesenteric or mediastinal) nodes. The inguinal, external and common iliac,

Fig. 11. Lymphedema following radiotherapy. Edema of the lower extremity following radiotherapy for Kaposi's sarcoma. Dermal backflow once again can be seen.

Fig. 12. Acquired lymphedema. Lymphatic obstruction with edema. Carcinoma of the prostate with a large pelvic mass obstructing the left lymphatic chain. Collateral channels can be observed.

Fig. 13. Acquired lymphedema. Lymphatic obstruction with edema. Superior vena caval obstruction was also present. Collateral channels are demonstrated.

para-aortic, and lower supraclavicular nodes are seen following injection of the lymphatics of the lower extremity. The axillary and a portion of the supraclavicular nodes are visualized with upper extremity injection. The contrast material follows the course of normal lymph flow, entering the node through the sinusoids and leaving through the efferent lymphatics at the hilus. According to Collette (7), there are eight to twelve afferent and fewer efferent channels.

Inflammation of the Lymph Nodes: In acute inflammation, as demonstrated by a case of acute thrombophlebitis, there is dilatation of the local lymphatics (Fig. 17). The local nodes are considerably enlarged, but the normal architecture is main-

Fig. 14. Lymphatic obstruction without edema. A. Adequate collateral pathways developing after inguinal node dissection for carcinoma of the penis. B. Extensive collateral lymphatic circulation. Pelvic mass due to Hodgkin's disease obstructing the lymphatic chain.

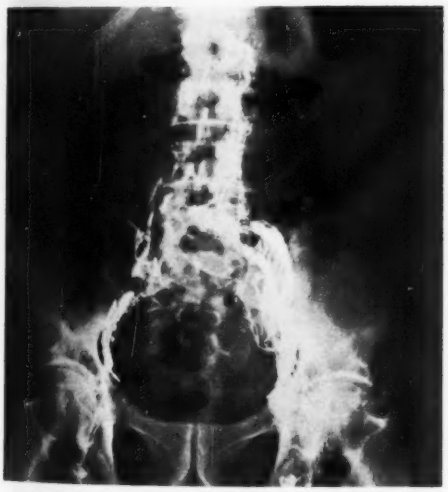

Fig. 15. Distortion of the left iliac lymphatic chain by a pelvic mass in a patient with carcinoma of the penis.

tained. In one patient with a generalized viral disease, this same pattern was seen in the majority of the nodes visualized.

Carcinoma of the Lymph Nodes: Metastatic carcinoma of the lymph nodes can be

Fig. 16. Normal lymph node. Multiple fine afferent lymphatics are seen entering the node and larger efferent lymphatics leaving at the hilus. The node has a homogeneous reticular pattern with a well defined margin.

demonstrated by lymphangiography. In metastatic areas there is an increase in the number and size of nodes visualized. A characteristic pattern is produced, which consists of irregular filling defects in the margin of the node, giving it a "moth-eaten" appearance. This is presumably due to embolic carcinomatous metastases. Collette has described such nodes in the pelvis as having enlarged afferent lymphatics; because of the poor filling of the sinusoids, the nodes are of irregular shape, with the defects primarily at the margins, at the site of entrance of the afferent vessels. Fischer demonstrated experimentally in animals that space-taking lesions within the nodes can be clearly visualized. These lesions were simulated by the implantation of polyethylene balls or by the production of sterile abscesses with electrocautery. Intralymphatic injections

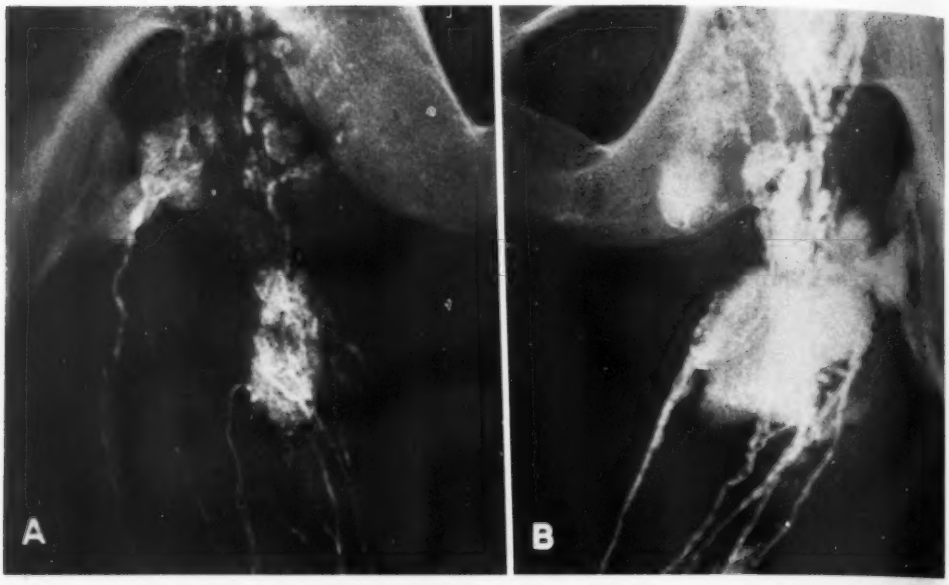

Fig. 17. A. Normal femoral nodes and lymphatics. B. Acute inflammatory changes in the femoral nodes. Note the dilated lymphatics and the enlarged nodes.

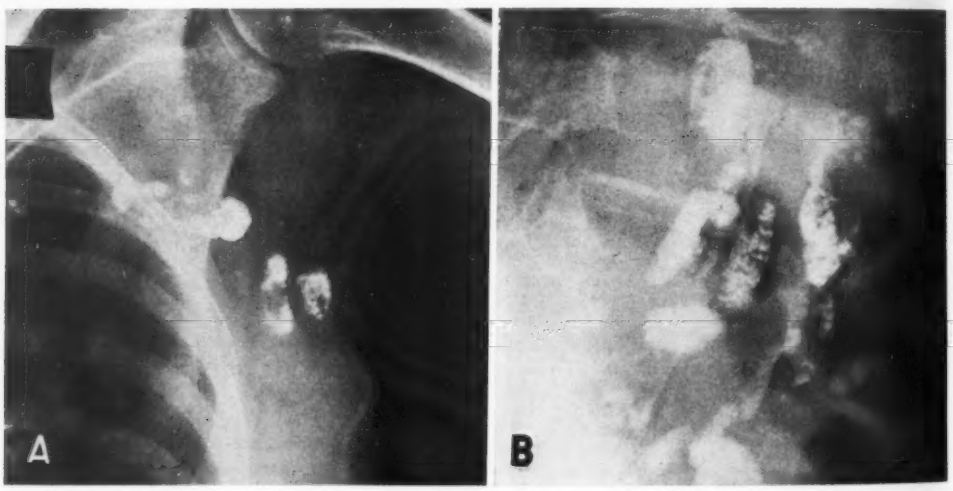

Fig. 18. Metastatic carcinoma. A. Axillary lymph nodes involved by metastatic carcinoma from the breast. B. Metastatic carcinoma of the para-aortic nodes from a primary carcinoma of the rectum.

satisfactorily demonstrated these defects.

Zeidman, Copeland, and Warren (30) injected blue dye and radioactive gold into carcinomatous nodes of rabbits. Radioautography revealed no freely communicating channels between the normal portions of the node and its contained cancer. Even with injection under high pressure with the efferent lymphatics occluded, there was no perfusion through the neoplasm. The carcinoma invades and blocks the lymph spaces; therefore the oil base contrast material will outline only normally functioning lymphoid tissue.

The "moth-eaten" pattern of partial nodal replacement is illustrated by 3 cases.

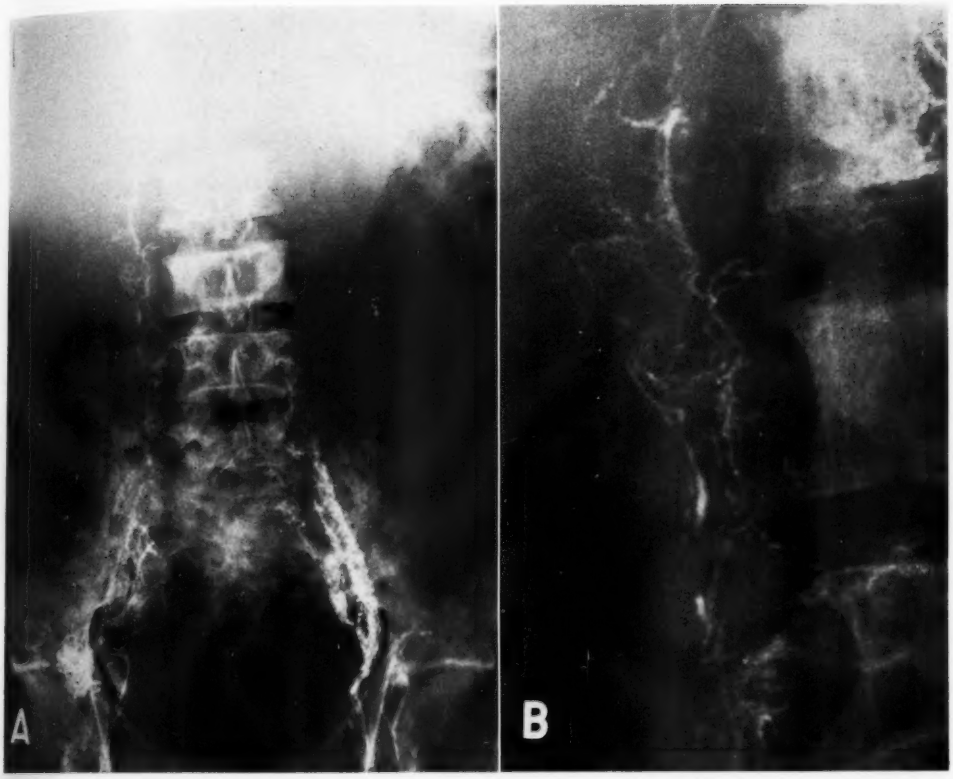

Fig. 19. Effect of total replacement of nodes by metastatic carcinoma. A. This patient had carcinoma of the prostate with extensive metastatic carcinoma of the retroperitoneal nodes. The nodes are not demonstrated. B. The lymphatics circumvent the totally replaced nodes.

Figure 18, A demonstrates metastatic nodes from carcinoma of the breast. The second case is one of carcinoma of the rectum with metastasis to the para-aortic nodes (Fig. 18, B). The last case shows the effect of complete replacement of the para-aortic nodes in a case of metastasis from a prostatic carcinoma (Fig. 19). Although the enlarged nodes cannot themselves be visualized, the deviated lymphatics give away their presence. With metastatic nodal involvement there is an increase in the number of lymphatics and nodes seen, which may be due to the visualization of different pathways or new node formation.

Lymphoma: In lymphomatous diseases, the lymph nodes are enlarged and have a foamy or lacy pattern which produces an almost ghost-like appearance. In contrast to invasion by metastatic carcinoma, the important finding is preservation of the outer margin of the node. This is consistent with the pathologic change in lymphomatous disease, which is initiated within the node and spreads diffusely through it. Our experience suggests that some lymphomatous diseases have characteristic patterns. Nodes involved with lymphosarcoma, as seen in Figures 20, A and B, are enlarged, the margins are maintained, and there is a foamy or lacy pattern. In Hodgkin's disease, as shown in Figure 20, C, the nodes are large, with the borders preserved but scattered areas of moth-eaten replacement are present within the node. In 2 patients with chronic lymphatic leukemia, an identical pattern was seen, with enlarged nodes having basically a lacy architecture, continuous margins, and areas

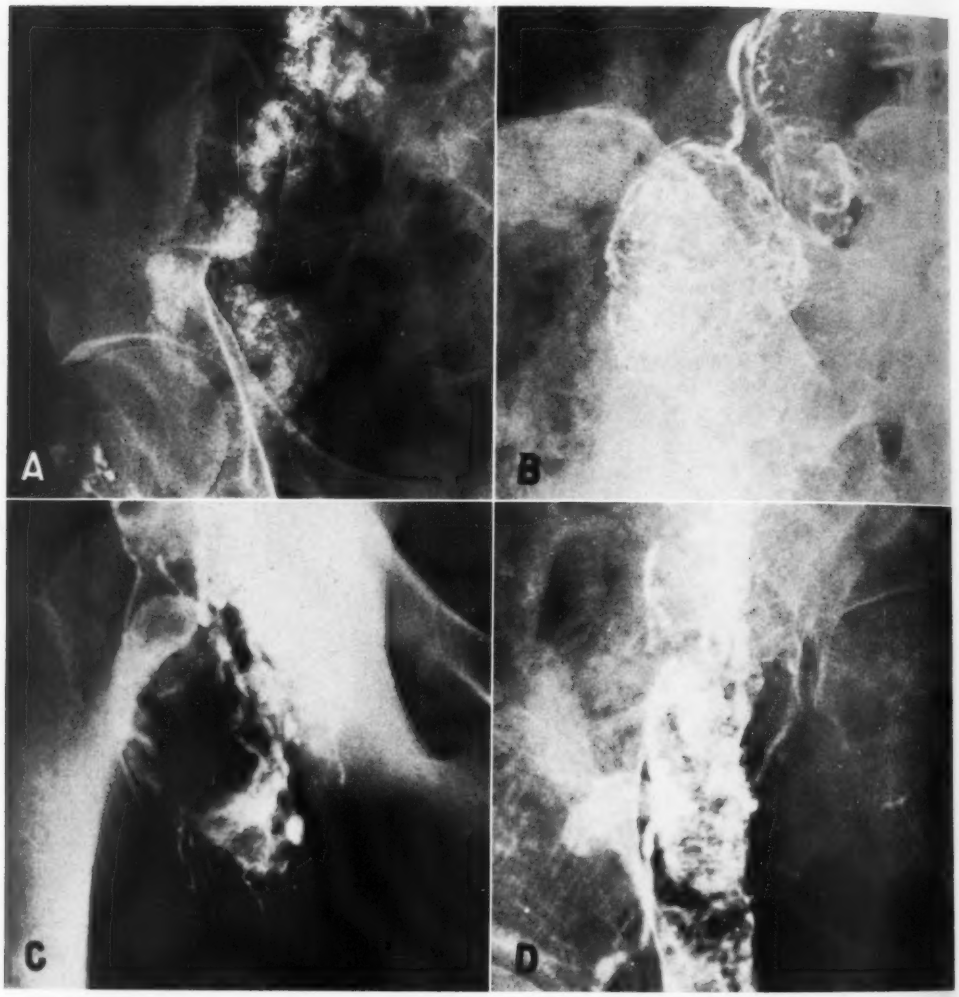

Fig. 20. Lymphomatous involvement of lymph nodes. These nodes show a foamy internal architecture, with preservation of the nodal margins. A. Lymphosarcoma, early manifestations. B. Lymphosarcoma, late stage. C. Hodgkin's granuloma. D. Chronic lymphocytic leukemia.

of increased collections of opaque medium (Fig. 20, D). These basic criteria are employed in the evaluation of the patient studied by lymphangiography.

APPLICATIONS AND COMPLICATIONS

Lymphangiography is a practical method of radiographic demonstration of the lymphatic system. It can be utilized as a diagnostic tool and as a therapeutic aid which has definite practical clinical applications. The procedure requires a minimum of surgical proficiency, so that under the usual circumstances the technical aspects are accomplished in approximately half an hour.

Diagnosis: In cases of lymphedema, localized abnormalities of the lymphatic system can be demonstrated. Perhaps surgical approach to these congenital anomalies may be of value in correction of "idiopathic lymphedema."

Postoperative edema following radical mastectomy is frequently a distressing

Fig. 21. Postmastectomy edema. In this patient the lymphatics were decreased in caliber.

problem. Several such patients have been studied in this group. In one, the lymphatics were normal in number but decreased in caliber (Fig. 21). This finding differs from that of Kinmonth, who found the vessels near-normal in caliber but somewhat tortuous and with a tendency

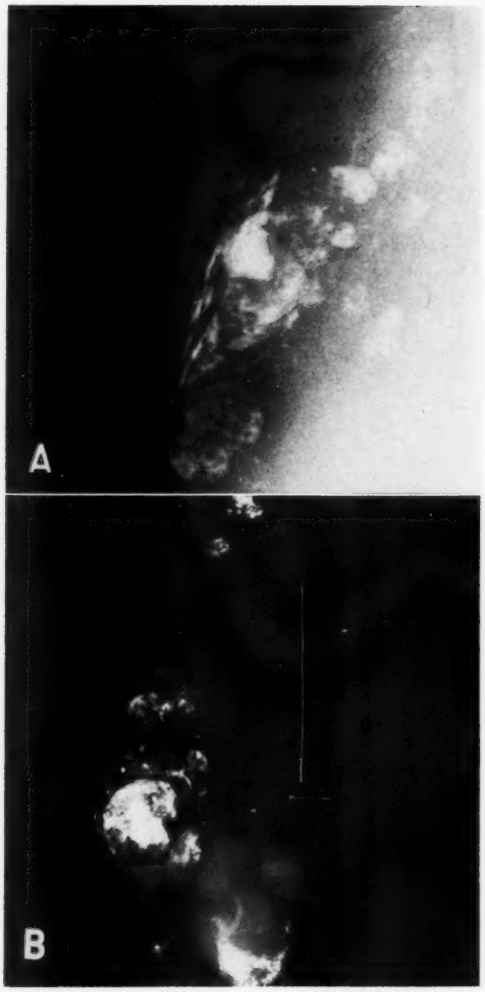

Fig. 22. A. Metastatic carcinoma of the breast with two palpable axillary nodes. All these nodes demonstrate evidence of metastatic disease.

B. Operative specimen: The nodes from the same patient were dissected free of the surrounding tissues. The nodes without contrast medium were totally replaced by carcinoma.

toward increased collateral flow. In a recent investigation by Smedal and Evans (27), by means of venography, several patients were found to have thrombophlebitis as the prime causative factor. In an attempt at a better study of postmastectomy edema, we are now using combined venography and lymphangiography. It is of interest that in a case of chronic thrombophlebitis of the lower extremity the

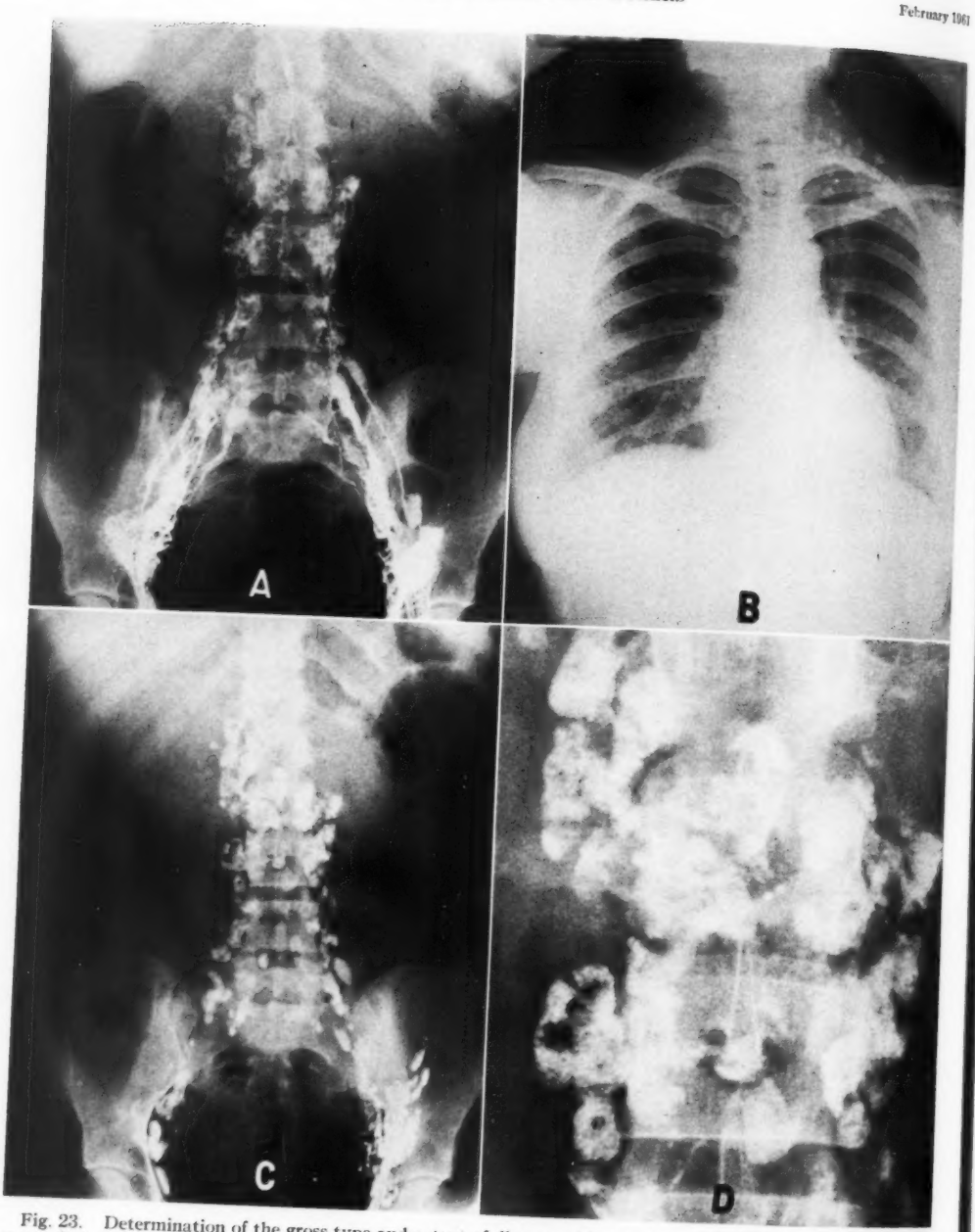

Fig. 23. Determination of the gross type and extent of disease. Hodgkin's granuloma with extensive involvement of retroperitoneal nodes. A. Roentgenogram taken immediately after the injection of the contrast material. B. Twenty-four-hour roentgenogram of the chest. The supraclavicular and lower cervical nodes are demonstrated. C. The retroperitoneal nodes are best visualized on the twenty-four-hour roentgenogram. D. These retroperitoneal nodes demonstrate the findings characteristic of Hodgkin's granuloma.

lymphatics were decreased in number and caliber somewhat as in post-mastectomy edema.

Diagnostically, lymphangiography can be best applied to the patient with malignant diseases. Demonstration of meta-

static carcinoma of the lymph nodes by this technic may furnish information of critical value in the presence of unsuspected metastatic disease, which may alter the therapeutic approach. Even in an accessible area such as the axilla, metastatic carcinoma may be present at the apex, and therefore out of reach of the palpating fingers. Figure 22, A represents a patient with an extensive lesion of the breast with two large firm axillary nodes. A lymphangiogram revealed multiple involved nodes. Note the worm-eaten appearance. A radical mastectomy was performed. All the nodes removed contained metastatic carcinoma. The areas visualized are residual functioning tissue. The majority of the nodes were totally replaced and showed no uptake of contrast material. Figure 22, B shows the dissected nodes. Those which were visualized were completely removed, as was shown in a postoperative chest film.

Lymphomas can also be readily shown by this technic. The lymphangiograms will frequently reveal diffuse malignant involvement where only local disease is manifest clinically. This was demonstrated by a patient with Hodgkin's granuloma believed to be localized in the supraclavicular area. Examination disclosed extensive disease in the retroperitoneal region. The nodes were typical of Hodgkin's disease, with a well defined outer margin and spotty replacement within (Fig. 23). Figure 24, A shows a reticulum-cell sarcoma producing distortion of the ureter. Fig. 24, B reveals displacement of the kidney by nodes involved by chronic lymphatic leukemia.

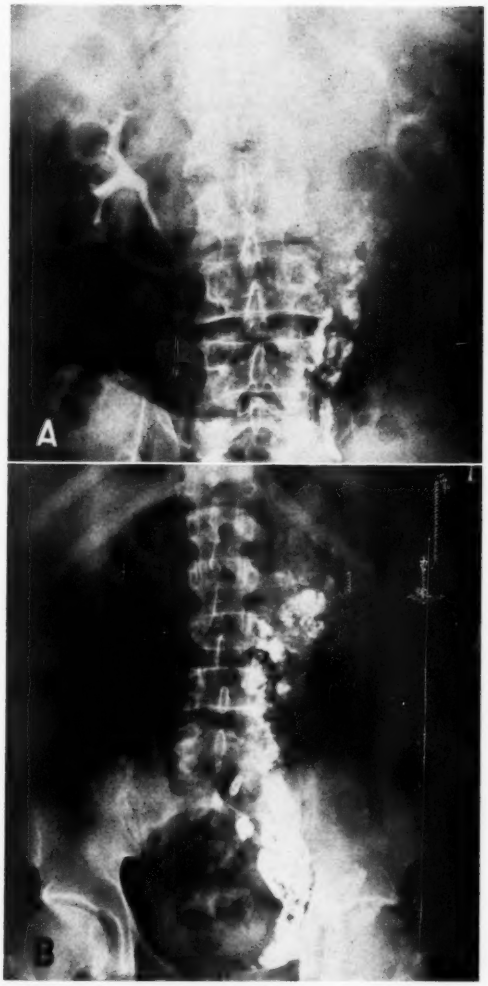

Fig. 24. Displacement of the genitourinary tract by involved retroperitoneal nodes. A. Reticulum-cell sarcoma involving nodes, producing distortion of the left ureter. B. Chronic lymphatic leukemia. Note the displacement of the left kidney.

In selected cases the exact location of tumor-producing symptoms was depicted. This has led to more specific therapy. In one patient, for example, who was known to have lymphosarcoma, urinary obstruction suddenly developed. Intravenous urography was inconclusive because of inadequate concentration of the contrast medium. The lymphangiogram depicted enlarged involved nodes in close proximity to the ureters. Radiation therapy to this area resulted in the relief of obstruction. In another case, a patient with a history of laryngectomy for carcinoma ten years previously complained of sudden back pain. No bony involvement, however, could be demonstrated. To our surprise the lymphangiogram revealed local involvement of retroperitoneal nodes at the level of the symptoms. This proved to be Hodgkin's disease, and subsequent irradiation brought about relief.

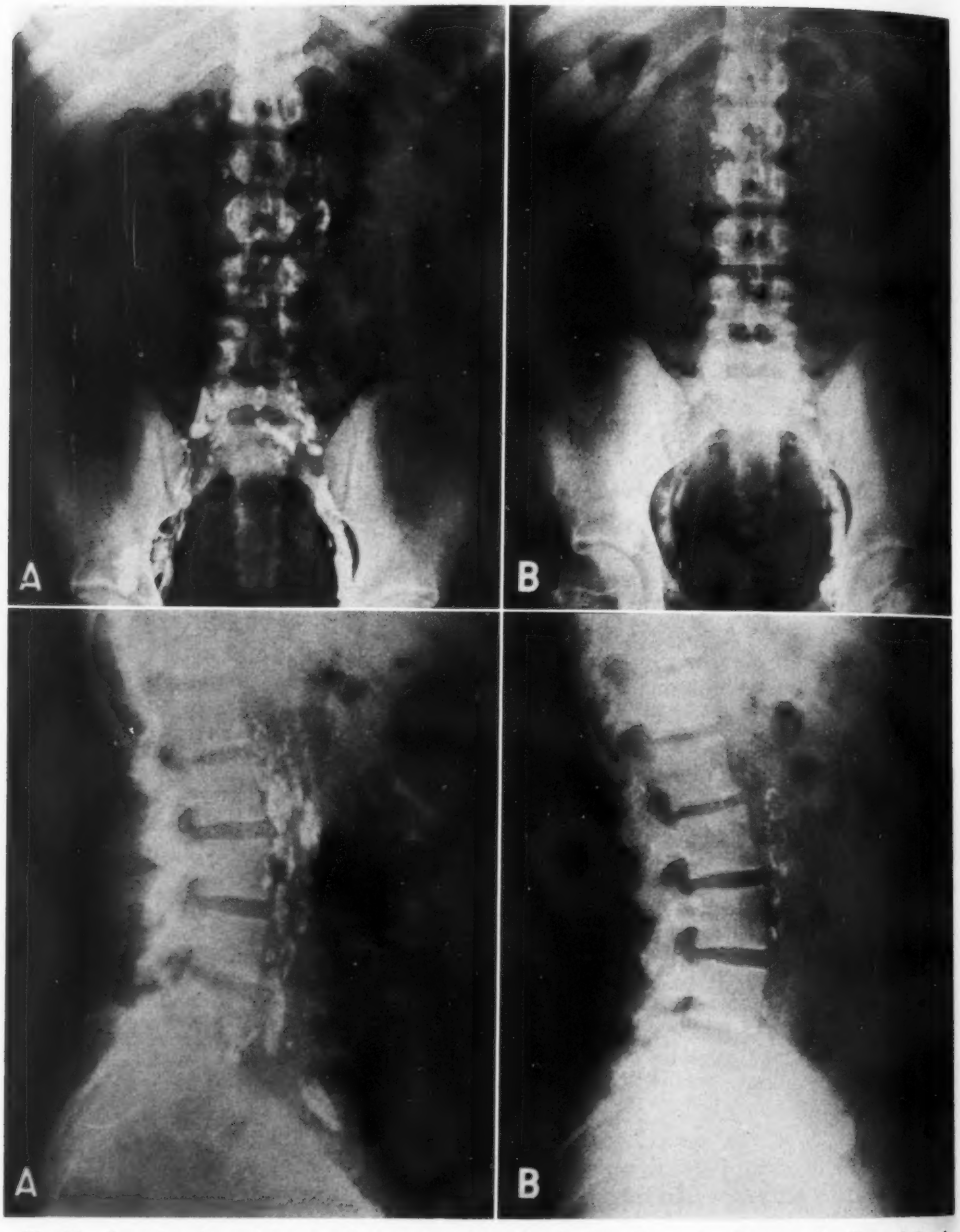

Fig. 25. Lymphangiography as a guide to retroperitoneal node dissection. A. Preoperative films of the abdomen, both anteroposterior and lateral, in a patient with teratocarcinoma of the left testicle. Note the suspicious nodes to the left of the 2nd lumbar vertebra. B. Postoperative roentgenograms reveal residual nodes. The questionably involved nodes are still present.

Therapeutic Applications: Lymphangiography can be a valuable aid to the surgeon. This procedure performed prior to lymph-node dissection can be used to give the surgeon a more exact visual picture of the location and status of the nodes.

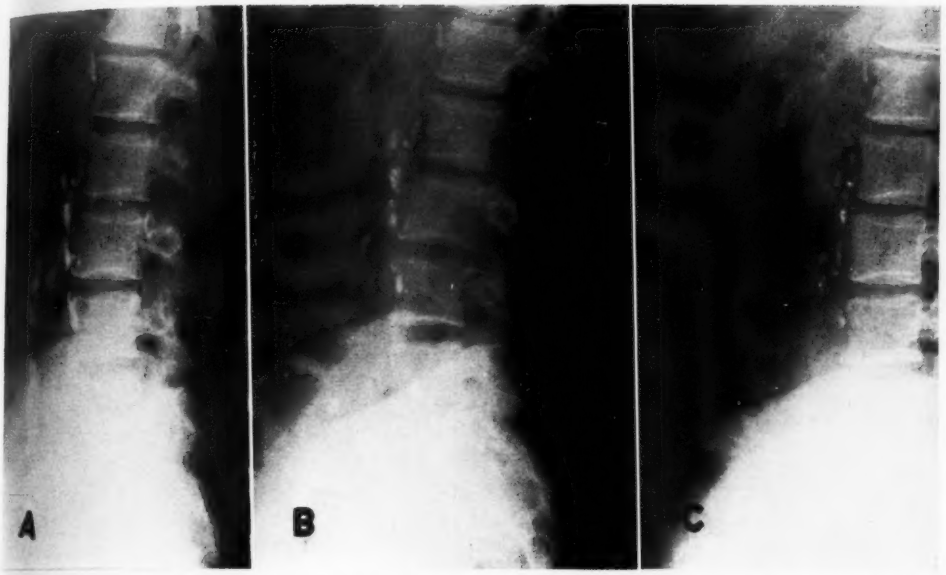

Fig. 26. Lymphangiography as a surgical and radiotherapeutic guide. A. The preoperative examination of a patient with teratocarcinoma of the testicle. B. Postoperative roentgenogram showing many residual nodes. C. Post-radiotherapy film. The nodes are markedly decreased in size but maintain the same configuration. The change is due to the effect of treatment rather than the loss of contrast material from the node.

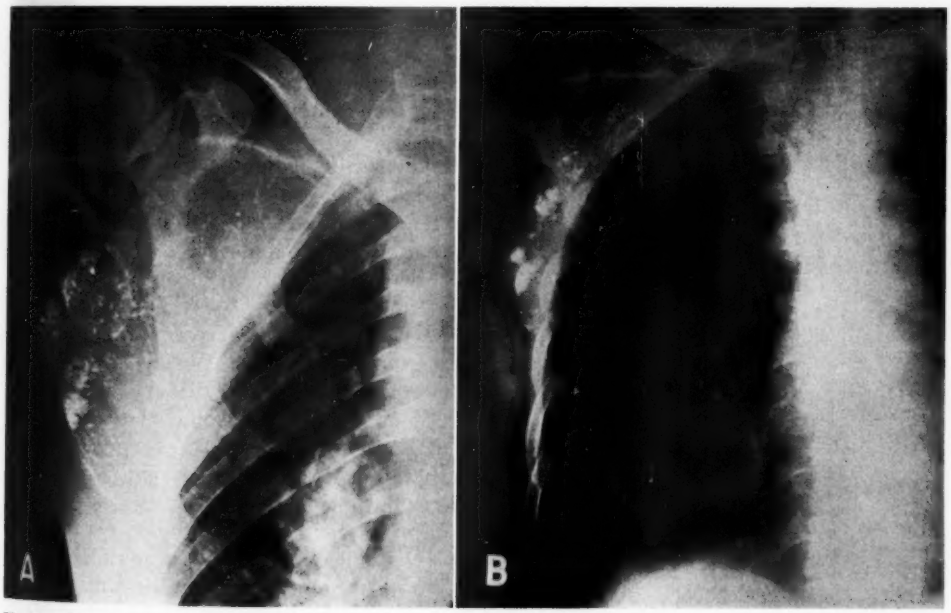

Fig. 27. Evaluation of the effect of radiotherapy. A. The axillary nodes show lymphosarcoma. B. Eleven days following the initiation of radiotherapy.

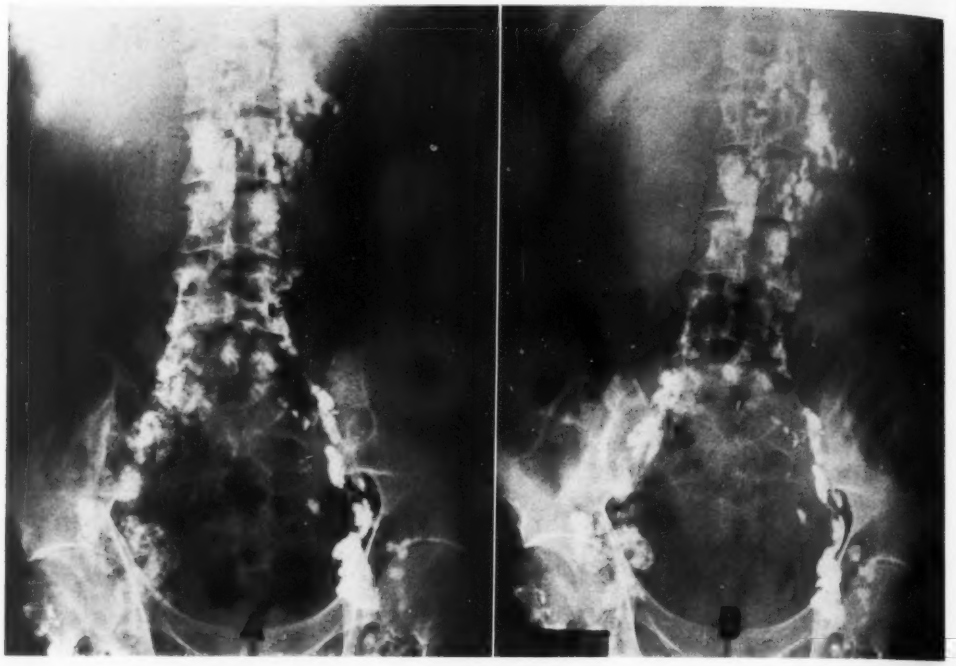

Fig. 28. Effect of chemotherapy. A. Lymphosarcoma of retroperitoneal and pelvic nodes. B. One week after initiation of cyclophosphamide therapy. C. Six months follow-up. The nodes are smaller, well visualized, and have the same configuration.

An example of this is seen in Figures 25, A and B, which show pre- and postoperative films of the retroperitoneal nodes of a patient with teratocarcinoma of the left testicle. Even though an apparently complete retroperitoneal node dissection was performed, the postoperative film revealed one node showing changes suggestive of involvement, which was left behind. Roentgenograms taken in the operating room may serve as a guide to complete removal of the nodes.

Lymphangiography can be utilized to great advantage by the radiotherapist, particularly in the more accurate placement of treatment portals. Our roentgenograms of the axillary nodes have demonstrated that some of these may lie at a distance below the clavicle and may therefore be missed by postmastectomy irradiation. Portal films can be more accurately centered over the proper area.

Visualization of the retroperitoneal nodes is a most helpful guide to the radiotherapist in the treatment of testicular tumor metastases. Crossing-over commonly takes place at the first sacral area and both para-

aortic chains must be included down to this level. Figure 26, A is the preoperative picture; Figure 26, B postoperative, and Figure 26, C post-radiotherapy.

Therapeutic efficacy can also be more exactly determined because of the prolonged presence of the contrast medium.

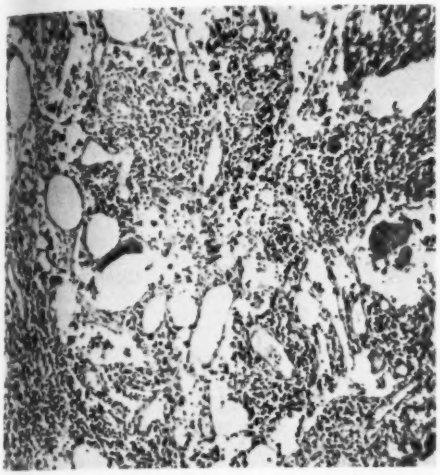

Fig. 29. Lipogranulomatous reaction in a lymph node. The vacuolated areas represent the spaces occupied by the oil-based contrast material. A foreign-body reaction is shown.

A patient with far advanced lymphosarcoma received radiotherapy to the axilla. Eleven days after the initiation of treatment, a follow-up film dramatically revealed the regression of the nodes (Figs. 27, A and B).

The latter use also applies to chemotherapy of disseminated malignant disease. Not only does it give the chemotherapist a guide to the effect of treatment in the individual patient, but it also gives him another practical parameter for objective evaluation of his therapeutic agents. This is demonstrated beautifully by a case of lymphosarcoma (Fig. 28, A) treated by intralymphatic and oral cyclophosphamide. Films taken in one week showed considerable regression (Fig. 28, B). Follow-up roentgenograms after six months once again show the nodes to be much smaller but with the same general configuration (Fig. 28, C). With exacerbation of the disease, the nodes will once again enlarge and revert to the previous status.

Fig. 30. Pulmonary embolization. Fine stippled areas of increased density.

Intralymphatic injection of chemotherapeutic agents following the demonstration of nodes involved by neoplasm has been attempted. Thus far only a few patients have been treated, without very rewarding results.

Complications: In performing lymphangiography on 207 extremities in 110 patients, we have encountered infrequent and minor complications. Two of our patients experienced a transient lymphangitis, which we assumed to be chemical in nature. This rapidly responded to local therapy. Local wound inflammation has occurred occasionally and led to frank wound infection in 3 instances. Histologic examination of nodes removed at surgery following lymphangiography has shown lipoid material producing a foreign-body reaction, a lipogranuloma (Fig. 29). The significance of this observation is not known at present. In a repeat study after ten months we have not demonstrated any nodal changes which could be ascribed to the previous study. There is always the possibility of the contrast material enter-

ing the venous circulation either too rapidly or in an excessive quantity. This can lead to fine pulmonary embolization, and we have observed this in a few patients (Fig. 30). In 6 of these a febrile response developed which was self-limited and subsided within three days without significant morbidity. The contrast medium itself has always cleared completely within a week. We attempt to avoid this complication by limiting the quantity of injected material in each patient. A theoretically possible complication is further spread of tumor emboli as a result of lymphangiography. This phenomenon is difficult to investigate. The work of Zeidman *et al.* (30), however, suggests that it is a remote risk. Lastly, one must always keep in mind the possibility of iodine sensitivity.

SUMMARY

By a modification of Kinmonth's method of intralymphatic injection, the lymphatics and nodes of the extremities have been demonstrated, including the pelvic, paraaortic, axillary, and supraclavicular areas, as well as the thoracic duct.

In lymphedema the findings vary from an increase to an almost complete absence of channels. Extensive collateral pathways in the face of obstruction to lymph flow have been shown.

Normal nodes exhibit a homogeneous reticular pattern. In lymphadenitis, the nodes are larger but normal in architecture; in lymphomas there are enlarged, lacy, ghost-like nodes; in carcinoma the nodes have a moth-eaten appearance.

Lymphangiography can be used to determine the general type and extent of disease processes; as a guide to lymph node dissection; in radiation therapy for portal placement; and in both radiotherapy and chemotherapy to assess the response to treatment.

ACKNOWLEDGMENTS: The authors express their appreciation to Dr. Philip Hodes, Dr. Bernard P. Widmann, and Dr. Stanley Dische for their assistance in this study. They are also grateful to the Veteran's Administration Hospital, St. Joseph's Hospital of Philadelphia, and the Albert Einstein Medical Center for the privilege of studying some of their patients.

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SUMMARIO IN INTERLINGUA

Lymphangiogrammas: Lor Potential Diagnostic e Therapeutic

Per medio de un modification del methodo de Kinmonth de injectiones intralymphatic, le vasos lymphatic e le nodos esseva demonstrate in le extremitates e etiam in le areas pelvic, para-aortic, axillari, e supraclavicular, si ben como le ducto thoracic. In lymphedema, le constatationes varia ab un augmento usque ad un quasi complete absentia de canales. Extense circuitos collateral in le presentia de obstruction del fluxo lymphatic essèva demonstrate.

Nodos normal exhibi un homogenee configuration reticular. In lymphadenitis, le nodos es allargate sed de architectura normal. In lymphoma, le nodos es allargate, dentellate, e spectral. In carcinoma, le apparentia del nodos es "erodite per tineas."

Lymphangiographia pote esser usate pro determinar le typo general e le extension del processos morbide. Illo pote servir como guida in le dissection de nodos lymphatic. In radiotherapia illo assiste in le placiamento del porta. Tanto in radiotherapia como etiam in chimotherapia illo adjuta in le evalutation del responsa al tractamento.

Radiologic Considerations of the Perinatal Distress Syndrome[1]

EDWARD B. SINGLETON, M.D., HARVEY M. ROSENBERG, M.D., and LUIS SAMPER, M.D.

DURING THE past decade many articles have appeared in the medical literature describing the causes, symptomatology, and radiologic findings of perinatal distress. Many of these publications include under this terminology any condition responsible for respiratory difficulty in the newborn infant. Consequently, there has developed some degree of confusion regarding the nomenclature of both neonatal and perinatal distress.

In the newborn there are many abnormalities, including intracranial lesions, numerous primary pulmonary anomalies, cardiovascular defects, and defects of the diaphragm, which may be responsible for the clinical manifestations of respiratory difficulty. Each of these conditions interferes either mechanically or physiologically with the normal process of respiratory exchange; the cause is usually some anatomical defect which can be recognized by standard clinical, laboratory, or radiographic procedures. Examples include tracheoesophageal fistula, diaphragmatic hernia, congenital heart disease, congenital lobar emphysema, multicystic lung disease, pulmonary agenesis or hypoplasia, intrathoracic masses, and subdural hematomas. In addition, in some infants the respiratory distress arises from circumstances which may also affect one or several organs, including the central nervous system, the liver, the adrenal glands, and the alimentary tract. These latter conditions, as well as a select number of primary pulmonary abnormalities which are described below, constitute the perinatal distress syndrome and have the common underlying factor of anoxia and shock (6), occurring in the pre-, intra- or post-partum period. In the perinatal environment a number of obstetrical complications may interfere with the normal circulation across the placenta, resulting in fetal anoxia.

It is the purpose of the present paper to discuss the radiologic manifestations of the conditions which in our opinion are the sequelae of hypoxia or anoxia in the perinatal period, *i.e.*, directly prior to delivery, during the birth process, or immediately thereafter: In many instances the obstetrical history will indicate a condition which will be compatible with fetal anoxia. At other times only the effects upon the fetus are evident.

Just as there is a common denominator in all of these states, anoxia, there is apparently a common pathogenesis, namely, increased capillary fragility and permeability. Anomalous physiologic responses such as premature respiratory stimulation may also play a role. Neurological influences such as vagal stimulation, with relaxation of the anus, may result in meconium staining of amniotic fluid. The combination of these factors frequently leads to aspiration of amniotic fluid and meconium.

The pathologic sequelae of the association of anoxia and increased capillary fragility may be in the form of petechiae or larger hemorrhages. Virtually all organs in all sections of the body, including the brain, spinal cord, lungs, heart, liver, kidneys, adrenal glands, and gonads, may be affected. Examples of this relationship are shown in Table I, but illustrative cases to be presented in detail in the text will be limited to those conditions which can be demonstrated radiologically.

Although associated factors may contribute to the pathologic results, it is clearly established that capillary structure is severely weakened by anoxia (14), and

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TABLE I: PERINATAL DISTRESS

Etiology	Pathogenesis	Anatomic Change
1. Maternal factors a. Toxemia b. Premature separation of placenta c. Diabetes 2. Placental insufficiency 3. Umbilical cord abnormality a. Prolapse b. Inflammation c. Malformations 4. Anemia a. Erythroblastosis b. Hemorrhage into maternal circulation 5. Prematurity 6. Cesarean section 7. Unknown	→ Anoxia → Vascular damage→ ↓ ↑ ↓ → Anomalous physiologic response Inflammation→	Generalized petechiae Coronary artery necrosis Pulmonary hyaline membrane Pulmonary hemorrhage Aspiration syndrome Esophagitis Perforation of gut ? Intestinal atresia "Two-toned" liver Pancreatic necrosis Adrenal hemorrhage Cerebral hemorrhage, subarachnoid, intracerebral, or extraventricular

that each of the conditions listed under "Anatomic Change" in Table I may be explained by capillary damage with resulting passage of blood constituents into the surrounding interstitial tissues of the involved organs.

INTRACRANIAL HEMORRHAGES

Although the radiologic evaluation of traumatic intracranial hemorrhage in the newborn may disclose fractures or separation of cranial vault sutures, most intracranial hemorrhages secondary to anoxia are too small to produce visibly increased intracranial pressure, and consequently the roentgen examination is usually noncontributory. Hemorrhages secondary to anoxia are usually within the ventricles or in the subarachnoid spaces and most commonly affect premature infants. Occasionally, with massive bleeding into either the ventricles or subarachnoid spaces, there will be radiographic evidence of suture separation, but differentiation from traumatic subdural hematomas can be made only by subdural taps.

The clinical manifestations, as a rule, are those of respiratory distress. Breathing is weak and irregular, interrupted by periods of apnea. Other clinical evidence of central nervous system involvement is usually present.

Although associated pulmonary abnormalities are frequently present, in the form of hyaline membrane disease or evidence of aspiration, a radiologically normal chest in a newborn child with respiratory distress should alert the pediatrician and radiologist to the possibility of intracranial hemorrhage.

HYALINE MEMBRANE DISEASE

Hyaline membrane disease has in the past ten years received more attention and more space in both pediatric and radiologic publications than any other single pediatric problem. Much has been learned of its pathologic properties, but its etiology in many respects remains enigmatic. Despite the insistence of some that the diagnosis can be made solely on the histologic findings, the roentgen appearance is usually clear-cut, and chest radiography is the most diagnostic single procedure during life. An x-ray picture similar to that of hyaline membrane disease has been attributed to incomplete expansion of the lungs at birth but, as has been shown (13), neonatal expansion is usually accomplished during the first few breaths, and it is unusual to find areas of atelectasis in chest films made in the first hour of life in normal infants. The diagnosis of hyaline membrane disease should not be made in the presence of respiratory distress unless there are positive radiographic features (4).

Any infant subject during the perinatal period to obstetrical complications which may lead to anoxia is likely to have

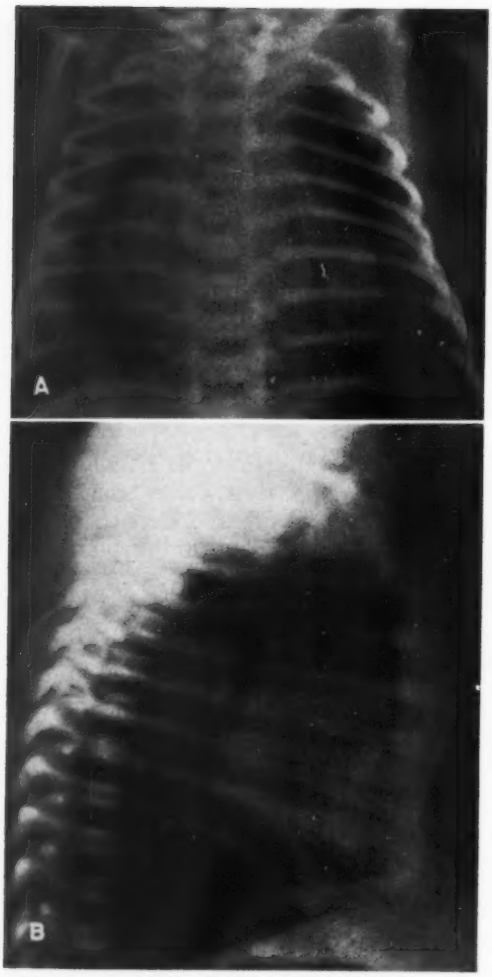

Fig. 1. Case I: Hyaline membrane disease. A. Chest roentgenogram showing slight cardiac enlargement and diffuse granular densities distributed uniformly throughout both lungs. The bronchial pattern is clearly identified.

B. Lateral view made during inspiration. Note retraction of the inferior portion of the sternum, as well as the reticulogranular appearance of the lungs.

respiratory distress during the postnatal period. This is especially true of the premature infant, of the section baby, and of babies born of diabetic mothers. Why hyaline membrane disease is more commonly seen in these children is unknown. The respiratory distress apparently begins at birth, for, although earlier reports emphasized that one or more hours elapse before it becomes evident, more careful studies have shown that, in the majority of cases, some distress occurs in the immediate neonatal period (10). There is usually a progressive increase in the severity of symptoms, consisting of cyanosis, rapid respirations, and retraction of the intercostal spaces and sternum. If the infant survives the first three or four days of the illness, the probability of recovery, with gradual regression of symptoms, is good.

The radiographic features are usually characteristic and frequently present before the respiratory difficulties become noticeable (3). The finding most commonly encountered is a reticular, granular pattern with a general increase in lung density. The reticular pattern is usually uniform throughout both lungs but may at times be especially pronounced in one area. In some cases the granular lesions may be of larger size. The thoracic cage appears well expanded, but pulmonary emphysema with flattening of the diaphragm and increase in the anteroposterior diameter of the chest is not a common finding in hyaline membrane disease. The air-filled bronchial tree is clearly delineated in most instances and produces sharp radiolucent contrast against the overall incompletely aerated lungs. The heart often displays some degree of enlargement. Pneumothorax and pneumomediastinum are occasionally present but are infrequent complications compared to the aspiration syndrome.

CASE I: S. A. T., a 26-hour-old white premature female, born at a local hospital, was transferred to the premature nursery at St. Luke's and Texas Children's Hospitals because of marked respiratory difficulty. Respirations became noticeably abnormal thirty minutes after birth and there was accompanying cyanosis. The mother, a gravida III, para 0, had been admitted to the neighboring hospital in labor. The membranes were intact and she was Rh-positive. The estimated term of gestation was thirty-four weeks, and there had been no known complications of pregnancy. Labor progressed satisfactorily and after six and a half hours the infant, in a left occiput anterior presentation, was delivered with the assistance of a midline episiotomy and low forceps.

Physical examination showed the respirations to

be 60 per minute, accompanied by an expiratory grunt. There was marked intercostal and substernal retraction on inspiration and little or no air exchange was heard on auscultation.

Radiographs of the chest made shortly after admission to the hospital demonstrated diffuse granularity of both lungs, and a lateral view made during inspiration showed evidence of the sternal retraction (Fig. 1). The heart was slightly enlarged, and bronchial markings were clearly seen within the lungs. There was no sign of pulmonary emphysema, and the minute reticulogranular densities occupied both lungs uniformly.

In spite of supportive measures, the infant's condition became progressively worse, with death approximately twelve hours after admission.

Postmortem examination showed hyaline membranes lining the alveoli and alveolar ducts. There were scattered petechiae on the serous surface of the thoracic viscera and multiple small areas of acute ulceration in the stomach mucosa.

ASPIRATION SYNDROME

Whereas hyaline membranes are more common in the premature infant, the aspiration syndrome is usually found in the postmature baby. It is apparently the result of the onset of respiration *in utero* or during passage through the birth canal.

Normally, after-birth respirations appear to begin in response to sensory stimuli: first, the change from intrauterine to the lower air temperature (13); second, the effect of anoxia upon the medulla. Conditions affecting the placenta or umbilical cord may provide this anoxic stimulus, with resulting initiation of respiratory movements *in utero* and the aspiration of amniotic fluid. The expulsion of meconium into the amniotic sac is an additional response of the postmature fetus to anoxia, and the presence of both fluid and particulate matter in the tracheobronchial tree may severely impair postnatal respiration.

In the aspiration syndrome the respiratory symptoms are similar to those of hyaline membrane disease, consisting of cyanosis and dyspnea, with intercostal and sternal retractions.

The radiographic findings are similar to those in other forms of aspiration pneumonia. Varying degrees of obstructive emphysema involving both lungs or a segment of the lung are present, with resulting overexpansion of the thoracic cage, increase in the anteroposterior diameter of the chest, and flattening of the diaphragm. Areas of increased density extend peripherally from the hilar regions, and patchy or segmental densities, representing both consolidation and atelectasis, are present throughout one or both lungs. Pneumothorax and pneumomediastinum are common complications in the severe cases.

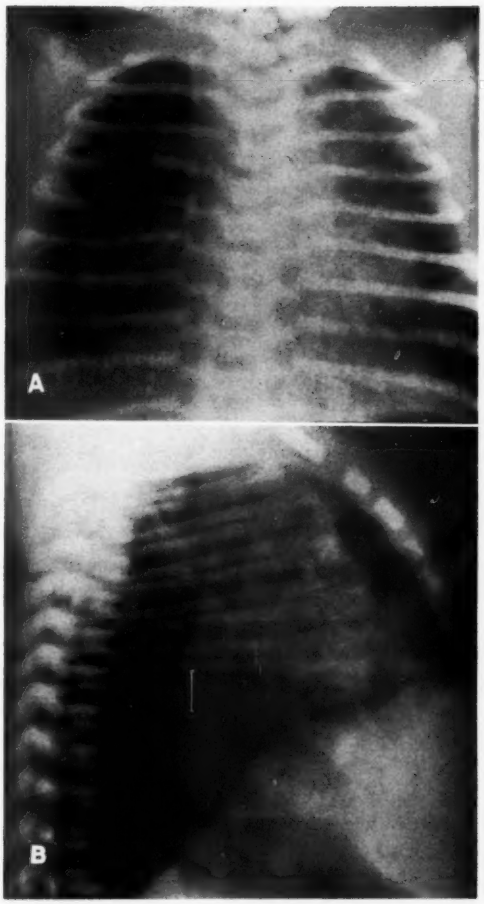

Fig. 2. Case II: Aspiration syndrome. A. Chest roentgenogram showing linear areas of increased density extending out from each hilus with patchy areas of consolidation throughout both lower lobes.

B. Lateral view demonstrating marked increase in the anteroposterior diameter of the chest and flattening of the diaphragm characteristic of generalized emphysema.

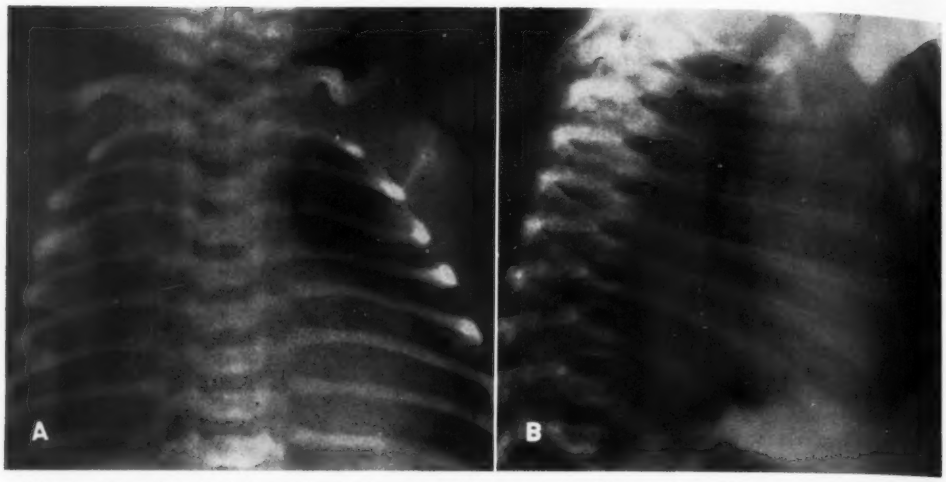

Fig. 3. Case III: Pulmonary hemorrhage. A. Linear areas of increased density are present in both lungs, more severe on the right.
B. Lateral view showing some evidence of overaeration of the lungs.

CASE II: D. C., a 9 lb. 8 oz. white male, was the product of a forty-three-week gestation. Pregnancy and labor were uncomplicated, but the amniotic fluid and infant were meconium-stained. There was difficulty in resuscitation following birth and, once respirations were established, they were rapid and associated with moderate sternal retraction.

Physical examination disclosed mild cyanosis, pulmonary emphysema, and multiple inspiratory and expiratory râles and rhonchi.

Radiographic studies demonstrated overexpansion of the lungs, with depression of the diaphragm and increase in the anteroposterior diameter of the chest (Fig. 2). Multiple linear and patchy areas of increased density were identified in both lungs, being especially prominent in the perihilar areas. The heart was of normal size.

The patient's condition continued to deteriorate until death, thirty-six hours after admission to the hospital.

Postmortem examination showed multiple areas of consolidation with extensive amniotic debris in many of the major and minor bronchial segments. There were some focal areas of hyaline membrane formation, as well as pulmonary hemorrhage.

PULMONARY HEMORRHAGE

Pulmonary hemorrhage in the newborn may occur in small, clinically insignificant amounts or may at times be massive, resulting in rapid demise. Fetal anoxia is probably the most probable cause, although this may be complicated by hypothrombinemia or hemorrhagic disease of the newborn. Pulmonary hemorrhage frequently accompanies fatal erythroblastosis fetalis.

Clinical findings may be limited to respiratory distress or, in the severe cases, there may be hematemesis or the passage of large amounts of frothy blood from the nose and mouth.

Radiographs of the chest show changes similar to those in infants with the aspiration syndrome. There are linear and patchy areas of increased density, usually in both lungs, and the prominence of the markings and the distribution depend upon the severity of the intra-alveolar hemorrhages.

CASE III: K. B., a 3-day-old white male, was the product of a normal pregnancy, labor, and delivery. Following birth the infant appeared well but at three days of age became cyanotic and hypotonic.

Physical examination showed a well developed baby of 6 lb. 8 oz., in moderate respiratory distress, who did not respond to stimulation. Multiple rhonchi were heard over the right hemithorax.

Chest radiographs showed linear areas of increased density throughout both lungs, more prominent on the right (Fig. 3). A few small areas of consolidation were also identified, and mild pulmonary emphysema was present.

Death occurred on the fifth day of life, after several convulsive episodes.

Postmortem examination demonstrated extensive

TABLE II: ANOXIC LESIONS OF THE ALIMENTARY TRACT

Case	Age and Sex	Age of Onset	Obstetrical and Birth History	Symptoms	Roentgen Examination	Treatment and Results	Pathology
IV.	2½ days, M	2 days	36 weeks gestation. Mongoloid	Abdominal distention	Pneumoperitoneum	Surgery. Death	Perforated ulcer of stomach
V.	1 day, F	6 hours	Negative	Abdominal distention and cyanosis of feet	Pneumoperitoneum	Death	Perforated ulcer of colon
VI.	Newborn, M	Birth	Premature	Listless; dusky	Pneumoperitoneum	Surgery. Death	Perforated ulcer of ileum
VII.	2 days, F	Birth	Negative	Abdominal distention	Distention of small bowel and colon	Death	Inflammatory lesions of ileum
VIII.	7 days, F	Birth	8 months gestation	Abdominal distention. Cheyne-Stokes respiration	Low small bowel obstruction	Death	Inflammatory lesion of ileum with stenosis. Focal subarachnoid hemorrhage
IX.	2 weeks, F	2 days	Negative	Abdominal distention, vomiting, mongolism	No examination	Death	Perforated cecum with enterocolitis of ileum and cecum
X.	17 days, F	Birth	Prolonged labor	Poor suck. Vomiting	Negative abdominal, upper gastrointestinal, colon	Surgery. Death	Perforated ulcer of sigmoid
XI.	1 month, M	Birth	Negative	Abdominal distention, vomiting	Small bowel obstruction	Surgery. Survival	Focal necrosis of jejunum
XII.	8 weeks, M	6 weeks	Negative	Abdominal distention, vomiting	Small bowel obstruction	Surgery. Survival	Inflammatory stenosis of ileum
XIII.	3 months, F	1 day	Negative	Vomiting, distention, obstipation	Small bowel obstruction	Ileostomy. Death	Inflammatory stenosis of ileum

pulmonary intra-alveolar hemorrhage, as well as coarctation of the aorta with a patent ductus arteriosus. A single small subarachnoid hemorrhage was found in the brain.

NONINFECTIOUS ENTEROCOLITIS

The relationship of fetal or neonatal anoxia to lesions of the intestinal tract is not completely understood; yet certain abnormalities affecting the bowel of the neonate may be explained on the basis of focal vascular changes due to anoxemia. Ulcerations of the esophagus and, less commonly, of the stomach and duodenum, are readily recognized by the pathologists and are considered to be intimately related to anoxia or stress (12). A group of similar lesions are encountered in other portions of the alimentary tract, but are seen infrequently and are poorly understood. Because of the pathologic similarity between them and the anoxic lesions of the esophagus and stomach, they probably have a similar etiology. They have been described under the designation localized noninfectious enterocolitis of early infancy (12). The clinical manifestations consist of either perforation or cicatricial changes with obstruction. The earliest demonstrable pathologic alteration is a focal area of necrosis, resulting perhaps from focal vascular hemorrhage secondary to hypoxia or anoxia. If perforation occurs, pneumoperitoneum, often of extensive degree, develops, usually evidenced by abdominal distention. In the absence of perforation, an inflammatory reaction results, which may produce obstruction or be followed by scarring, with obstructive phenomena occurring several weeks later. Nine such cases have been seen at the Texas Children's Hospital. In each, there has been x-ray evidence of either pneumoperitoneum at birth or signs of obstruction in the neonatal period or

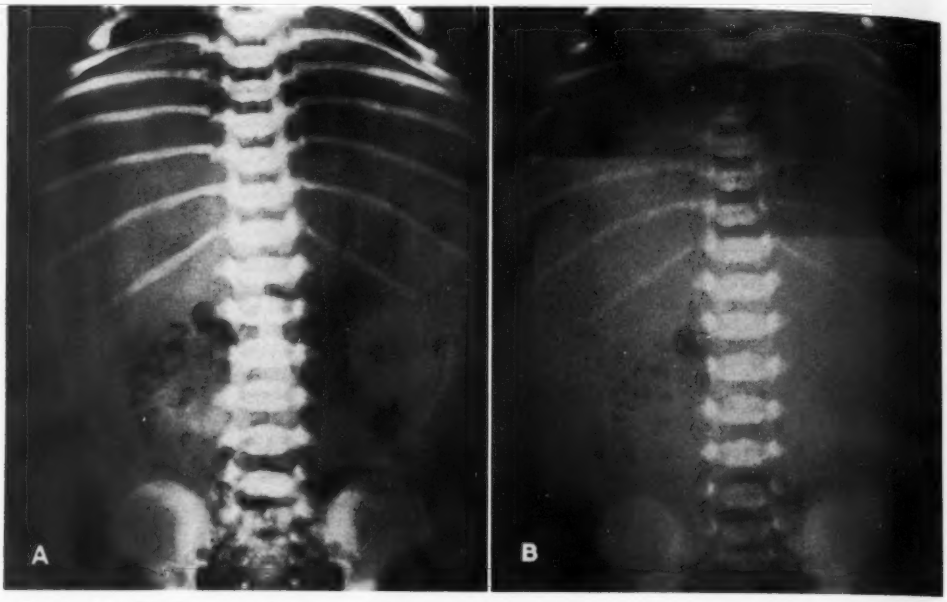

Fig. 4. Case IV: Pneumoperitoneum. A. Recumbent view showing extensive pneumoperitoneum. B. Upright film. In addition to the pneumoperitoneum, there is extensive accumulation of fluid in the peritoneal cavity.

during the first few weeks of life. Surgical exploration or necropsy findings have demonstrated an inflammatory reaction associated with ulceration or an inflammatory stenosis (Table II). In none of the cases, however, could pathogenic organisms be demonstrated as an underlying etiologic factor.

CASE IV: P. E., a white male 2 1/2 days old, was the product of an uncomplicated thirty-six-week gestation followed by a precipitous labor of three hours duration. At thirty-six hours of age the infant's abdomen became distended, and respiratory distress developed.

Physical examination revealed moderate tachypnea and marked distention of the abdomen. The chest showed evidence of decreased expansion without râles or abnormal breath sounds. Some of the physical characteristics of mongolism were thought to be present.

Radiographs of the abdomen, with the patient in supine and upright positions, showed extensive pneumoperitoneum (Fig. 4). In addition, free fluid was demonstrated within the abdominal cavity. There was no sign of intestinal obstruction, and only a small amount of gas was identified in the colon. Although the acetabular angles were within normal limits, there was evidence of flaring of the iliac wings, consistent with the clinical impression of mongolism.

Shortly after the x-ray examination an exploratory laparotomy was performed and a perforated ulcer of the anterior gastric wall was discovered and repaired. Supportive measures were instituted, but in spite of these the infant died eight hours after the operation.

Postmortem examination demonstrated a perforated gastric ulcer which had been surgically repaired, purulent peritonitis, mongolism, prematurity, and an atrial septal defect.

CASE V: T. S., a 1-day-old white female, was admitted to the Texas Children's Hospital because of abdominal distention and cyanosis which began six hours after birth. The obstetrical history was noncontributory, and delivery had occurred after a ten-hour labor. The child cried spontaneously and was considered normal until the onset of abdominal distention.

Physical examination showed a distended abdomen and moderate cyanosis of the feet. Respirations were rapid, and auscultation of the chest revealed markedly diminished breath sounds.

Radiographs demonstrated a large amount of free air in the abdominal cavity, elevation of the diaphragm, and extremely poor aeration of the lungs (Fig. 5). In addition, there was mild distention of the terminal small bowel.

Shortly after the roentgen examination the infant suffered cardiac arrest, which was unsuccessfully treated by cardiac massage and paracentesis.

On postmortem examination there was found a diffuse acute peritonitis secondary to a perforated

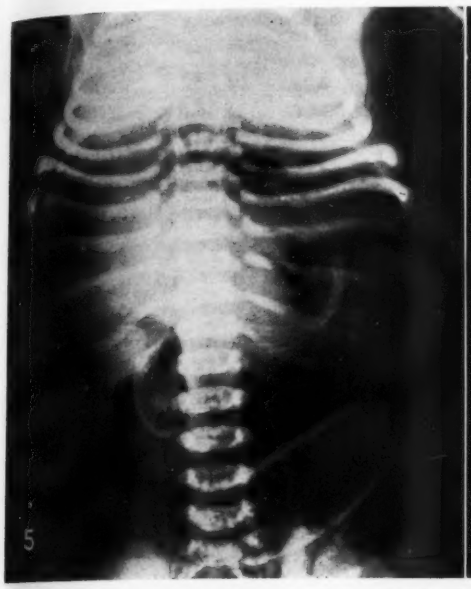

Fig. 5. Case V: Pneumoperitoneum. Scout film showing extensive pneumoperitoneum with associated distention of small bowel. The lungs are poorly aerated.

Fig. 6. Case VI: Pneumoperitoneum. Abdominal roentgenogram demonstrating free air in the peritoneal cavity, as well as mild distention of the small bowel.

ulcer of the ascending colon. Bacteriological studies of the perforated ulcer disclosed only coliform bacilli.

CASE VI: B. L., a newborn white male, was delivered spontaneously after a six-and-a-half-month gestation. The pregnancy had been uncomplicated except for periodical vaginal spotting beginning during the fifth month. The infant cried spontaneously but on arrival in the nursery following delivery, he exhibited mild generalized cyanosis as well as respiratory difficulty. In an Isolette, with oxygen and mist, he showed some improvement of the cyanosis but at twelve hours was dusky and extremely listless. At forty-eight hours the respirations became irregular, the cyanosis increased, and periods of apnea were noted. At eighty-two hours the abdomen was moderately distended and bowel sounds were absent. Shortly afterward, several convulsive episodes occurred.

Radiographs of the abdomen showed the presence of pneumoperitoneum, and moderate distention of the small bowel (Fig. 6).

Exploratory laparotomy demonstrated peritonitis secondary to perforation of an inflammatory lesion of the ileum. An ileostomy was performed, but the patient died two hours later.

Postmortem examination disclosed peritonitis, hemoperitoneum, intrapulmonary hemorrhage, and multiple intracerebral petechiae. Bacterial examination of the inflammatory lesion of the ileum disclosed no organisms that were thought to be pathogenic.

CASE VII: R. R., a 2-day-old white female, was admitted to the Texas Children's Hospital because of abdominal distention which had developed shortly after birth. Although the infant was premature, there was no history of maternal illness during the pregnancy, and the delivery was uncomplicated. The mother was Rh negative and the father Rh positive; a direct Coombs' test was negative.

Physical examination showed moderate respiratory distress as evidenced by tachypnea, but the major findings were limited to the abdomen, which was distended and silent.

Radiographs demonstrated moderate distention of the small bowel, as well as what was thought to be slight but less evident distention of the colon (Fig. 7). Barium-enema studies showed the colon to be slightly dilated. In addition, a small amount of contrast material entered the terminal ileum, where there was rather abrupt dilatation 3 inches proximal to the ileocecal valve.

Exploratory laparotomy, on the third hospital day, disclosed an inflammatory lesion of the terminal ileum with associated narrowing of that segment. Resection of the involved ileum was performed, with an end-to-end anastomosis. The patient did well during the following few days but on the eighth postoperative day began to vomit. The general condition rapidly deteriorated and death occured.

Postmortem examination showed extensive pulmonary edema, thought to have been the cause of

Fig. 7. Case VII: Abdominal roentgenogram showing moderate distention of the small bowel and, to a lesser degree, of the colon.

death. There was partial obstruction at the site of anastomosis. Examination of the resected segment of ileum failed to identify organisms which were considered pathogenic.

CASE XIII: R. K. G., a white female, was first seen at the Texas Children's Hospital at one day of age because of bile-tinged emesis of twenty-four hours duration. There had been no meconium stools, and mild abdominal distention was present. The obstetrical history was noncontributory, except for spontaneous delivery at approximately eight months gestation.

Physical examination showed moderate dehydration and a somewhat distended abdomen.

Roentgenograms demonstrated moderate distention of multiple loops of small bowel, with associated air-fluid levels noted on the lateral supine film (Figs. 8 and 9).

Laparotomy disclosed partial obstruction of the terminal ileum, thought to be due to inspissated meconium and consequently to represent meconium ileus. The lumen of the ileum was patent. Ileostomy was performed and the infant improved following this procedure. Tryptic activity of the stool was normal.

At the age of two months the patient was readmitted to the hospital because of vomiting of four to five days duration. Physical examination at this time again showed the abdomen to be distended, and radiographs disclosed evidence of small-bowel obstruction. The infant recovered from this episode of partial obstruction but was re-admitted three days after discharge from the hospital because of a recurrence of the distention. Surgical exploration at this time showed an area of ileal stenosis, which was resected. The specimen showed multiple areas of focal chronic inflammation and associated cicatricial changes. However, pathogenic organisms could not be cultivated from this inflammatory site. Several days following surgery the patient suffered wound disruption and died.

Postmortem examination revealed extensive pseudomembranous enterocolitis, which was thought to be responsible for death. There was no evidence of fibrocystic disease, and normal ganglion cells were present in the entire alimentary tract.

Fig. 8. Case XIII: Small bowel obstruction. Recumbent roentgenogram showing distention of the small intestine.

INTESTINAL ATRESIA

Although intestinal atresia is generally accepted as being the consequence of localized incomplete recanalization of the gut between the seventh and eleventh week of embryonic life, there is evidence suggesting that some forms result from interruption of the fetal blood supply to the atretic area (9). Anoxic factors may be etiologically related to the vascular deficiency. This will be considered in greater detail in the discussion.

The clinical findings of increasing abdominal distention and vomiting indicate the presence of an obstructive lesion. The absence of meconium stools or failure to identify epithelial cells (Farber's test)

in the stool is presumptive evidence of atresia. However, the occasional case in which normal-appearing meconium is present suggests that the atresia develops later in fetal life than could be accounted for on the basis of failure of embryonic recanalization of the gut.

The radiographic features consist of gaseous distention of the intestine proximal to the site of obstruction and multiple air-fluid levels usually shown on upright or decubitus films. The colon is abnormally small and devoid of gas.

Fig. 9. Lateral supine film of case shown in Fig. 8, demonstrating multiple air-fluid levels within the small bowel.

DISCUSSION

Anoxia affecting either the fetus *in utero* or the neonate during delivery or in the immediate postnatal period may result in increased capillary fragility and permeability, which in turn may lead to characteristic pathologic changes involving a variety of sites. These conditions, having a common denominator of anoxia and a common pathogenesis, *i.e.*, increased capillary fragility, constitute the perinatal distress syndrome. A number of them are radiologically demonstrable, whereas others are disclosed only at the time of necropsy.

Although the role of anoxia in producing capillary damage and increased capillary permeability is well established, the evidence of the relationship as a cause of the varieties of perinatal distress is not conclusive; the circumstantial evidence, however, is impressive and provides a logical pathogenic explanation.

Intracranial hemorrhages, either in the form of petechiae or more massive extravasations of blood, are commonly encountered in infants who have suffered from anoxia in intrauterine life or in the neonatal period. They are clearly recognizable by clinicians and pathologists as one of the unfortunate sequelae of fetal and neonatal anoxia. The effect of such hemorrhages upon the medulla may produce considerable respiratory distress. Although the degree is seldom severe enough to produce radiologic changes in the skull, intracranial hemorrhage should be suspected in any newborn infant with respiratory distress and a normal chest roentgenogram.

Infants with hyaline membrane disease are usually born prematurely under circumstances consistent with anoxia. Consequently the physiologic effect of anoxia upon capillary permeability offers a logical explanation for the development of hyaline membrane disease. Gitlin and Craig (5) have shown that the main component of hyaline membranes is fibrin. Insoluble fibrin, however, cannot be transferred across capillary barriers, and therefore apparently results from the transformation of fibrinogen. But, since the latter is present in amniotic fluid in insufficient amounts to account for hyaline membranes, it must permeate the alveolar capillaries. This transcapillary migration of fibrinogen is known to occur in small amounts normally; damaged capillaries permit the passage of abundant quantities. The conversion of fibrinogen to fibrin is dependent upon thromboplastin, a substance found in varying amounts in human amniotic fluid. Consequently, if effusion of fibrinogen from the pulmonary circulation has occurred into the alveoli and alveolar ducts, the aspiration of amniotic fluid by a fetus, either before birth or during delivery, would provide the necessary circumstances for hyaline membrane formation. It has also been suggested that infants in whom hyaline membranes develop are congenitally deficient in fibrinolysin. The great riddle is the explanation for the migration of fibrinogen through the pulmonary capillary walls. A number of theories have been advanced to explain this: cardiac failure with resulting increase in capillary pressure (15), oxygen poisoning (11), shock (8), aspiration of amniotic fluid alone, prematurity, and diabetes in the mother. A more logical explanation lies in the relationship of anoxia to increased capillary permeability. This increase in permeability as the result of anoxia would readily allow the effusion of fibrinogen into the alveoli and provide the necessary conditions for the formation of hyaline membranes.

The livers of infants who have suffered from anoxia may show changes which are apparently unique to perinatal distress. Gruenwald (6) described them as consisting of capillary congestion, degeneration of the liver cells, and necrosis of the walls of the arteries. In addition the appearances of the right and left halves of the liver differ, the greater degree of degeneration occurring in the right half because of the fact that the umbilical vein affords more oxygenated blood to the left. These anoxic changes are not demonstrated by roentgenographic methods but serve to illustrate the danger of anoxia to the fetal organs.

Hemorrhages into the adrenal gland may also result from anoxia and the consequent increase in capillary permeability. If the infant survives the perinatal distress period, the gland may undergo repair, with focal areas of calcification in the areas of degeneration and hemorrhage. The occasional inconsequential finding of adrenal calcifications on the radiograph of a normal child is not unusual in any pediatric institution. These calcifications have been attributed to rapid involution of the adrenal after birth (2). Because fresh adrenal hemorrhage is seen commonly at autopsy in a child who has suffered from anoxia, and because of the known association of anoxia and increased capillary permeability, calcification in the adrenal glands of older children probably represents the reparative end-result of this condition.

The work of Louw (9) is convincing in demonstrating that congenital intestinal atresia and stenosis in the newborn are in many instances due to the interruption of fetal blood supply to the involved segment of gut. This theory of vascular insufficiency originated over a hundred years ago but was generally discredited by Tandler's theory that atresia and stenosis of the bowel were the result of incomplete coalescence of vacuoles formed within the solid stage during embryonic life. The experimental work of Louw consisted in ligation of one or more mesenteric vessels of dog fetuses *in utero*, followed by examination of the puppies at the end

of gestation. Various types of atresia and stenosis were identified, similar to those found in the newborn infant. In addition, it was shown that the devitalized segments of bowel disintegrate rapidly, with the formation of a thin fibrous band or with complete absence of tissue in the area of devascularization. Local mesenteric defects were prominent and coincided with similar defects in intestinal atresia of newborn infants.

Although in most cases of intestinal atresia in the newborn meconium is either absent or unstained by bile, occasionally it contains abundant bile pigment, as well as epithelial cells and amniotic debris. While bile may pass from the blood stream through the bowel wall, the amount would be insufficient to provide meconium with a normal color. Intestinal atresia in infants with squamous epithelial cells and adequate bile in the meconium has obviously developed after the embryonic period and was not the result of localized incomplete recanalization of the embryonic gut. Although the causes of atresia developing after this period are unknown, embarrassment of the vascular supply to the site of involvement offers a reasonable explanation in view of Louw's experimental evidence. In addition, the effect of anoxia upon capillary structure suggests that fetal anoxia may play an important role in the pathogenesis of intestinal atresia. Mucosal necrosis, which is frequently seen in neonatal atresia, further suggests that impairment of blood supply prior to delivery may be an important factor in congenital obstructive lesions.

Noninfectious enterocolitis in young infants may represent damage to the bowel produced by a less severe or more focal area of vascular insufficiency. The condition may make its appearance at birth in the form of a localized ulceration of the esophagus, stomach, small intestine, or colon. With perforation of the bowel, pneumoperitoneum becomes obvious. In the absence of perforation, healing gradually occurs and the accompanying cicatricial changes may produce obstruction several weeks later. Experimental evidence for the supposition that anoxia may be responsible for the development of this condition is offered by Ingalls (7) who has shown that focal areas of bowel ulceration may be induced by hypoxia.

The absence of cerebral petechiae or pulmonary hemorrhages, hyaline membrane disease, and obstetrical complications in our cases of noninfectious enterocolitis would appear to contradict the theory of an anoxic vascular etiology. The possibility of this type of pathogenesis remains, however, as anoxia or insults to the fetus may readily occur without apparent maternal evidence. Future investigative work will undoubtedly clarify the issues and determine the overall importance of anoxia and vascular conditions constituting the perinatal distress syndrome.

SUMMARY

Anoxia or hypoxia affecting the fetus or the newborn infant may be responsible for the perinatal distress syndrome. Although the manifestations of this condition usually involve the respiratory tract, many other organs may be affected. The common underlying pathogenesis is apparently an increase in capillary fragility and permeability. The pathologic results from this relationship of anoxia and increased capillary fragility are variable and may affect any of the visceral components of the body. The radiologic manifestations of perinatal distress are discussed with special reference to the anoxic lesions of the alimentary tract.

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SUMMARIO IN INTERLINGUA

Considerationes Radiologic del Syndrome de Suffrimento Perinatal

Anoxia o hypoxia afficiente le feto o le infante neonate pote devenir responsabile pro le syndrome de suffrimento perinatal. Ben que le manifestationes de iste condition concerne usualmente le vias respiratori, multe altere organos pote esser afficite. Le subjacente pathogenese commun es apparentemente un augmento del fragilitate e permeabilitate capillari. Le resultatos pathologic de iste relation de anoxia con augmento del fragilitate capillari es variabile e pote afficer non importa le qual del componentes visceral del corpore. Le manifestationes radiologic del syndrome de suffrimento perinatal es discutite in relation con le sequente syndromes: Hemorrhagia intracranial, morbo de membrana hyalin, le syndrome de aspiration, hemorrhagia pulmonar, e—particularmente—enterocolitis non-infectiose.

Calcification of the Aortic Knob: Its Relationship to the Fifth and Sixth Embryonic Aortic Arches

A Radiological and Anatomical Study[1]

F. DALITH, M.D., Lt. Col., M.C., I.D.A.

CALCIUM DEPOSITS in the wall of the thoracic aorta constitute a frequent radiological observation in older persons and are considered to be a manifestation of arteriosclerosis (8, 13, 14). They may be widely distributed or concentrated in a small area (8). Very often the calcifications are seen in the aortic arch (8, 14). In the postero-anterior chest film they are visualized in the aortic knob as a comma-like (13), sickle-shaped (8, 14), or circular (14) opacity of calcific density. In the oblique position, more extensive calcifications of the thoracic aorta may be demonstrated as linear shadows or scattered clumps (14).

Semicircular calcifications in the aortic knob have also been observed in patients with patent ductus arteriosus (4, 5, 7, 10). It has even been suggested that they may constitute a confirmatory sign of patent ductus in young persons, in whom the presence of calcification from arteriosclerosis would be unlikely (10).

Our own experience, confirming the frequency of calcifications in the aortic arch in older persons, as well as its occurrence in patients with patent ductus arteriosus (Fig. 1), provided the incentive for this study. It was our purpose (*a*) to identify the *site of preference* of calcium deposition, (*b*) to investigate the *nature* of this finding, and (*c*) to explain its *radiological appearance.*

MATERIAL AND METHODS

Tomographic examinations in the anteroposterior and latero-oblique projections were made in 27 patients in whom a calcium-dense opacity at the aortic knob was demonstrated on a routine chest film. In addition, 100 aortic arch specimens were obtained from consecutive autopsies, fixed in formalin, and studied radiologically in three projections: "lateral" with the specimen lying on the film-holder; "anteroposterior," with the aortic arch held fast by a clamp in a position similar to that in the thorax; "open"—after a lengthwise incision through the brachiocephalic vessels—with the specimen fixed on a cork plate by needles. Every specimen was subjected to gross macroscopic examination and was transilluminated and photographed. Thereafter, tissue was excised for histologic examination.

TOMOGRAPHIC FEATURES IN THE PATIENT GROUP

Tomograms of patients taken in the *anteroposterior* projection demonstrated that the calcium-dense opacities were practically always situated in the wall of the aorta. The extent of calcification varied greatly. Small calcific densities are situated in the ventral part only; larger deposits extend from the ventral part to the left lateral wall, while still larger ones include the dorsal wall and may involve the entire circumference of the aorta (Fig. 2, A–D). The deposits were spot-like, comma-like, sickle-shaped, or circular. In the *latero-oblique* projection (Fig. 2, E–H) the calcium densities lay in the mid-portion of the aortic arch opposite the shadow of the pulmonary artery (2), appearing as rods and spindles. Frequently, two calcium plaques, about 1.5 cm. apart, were discerned (Fig. 3, A). In some patients linear calcium opacities were noted outside the aortic wall; these coursed obliquely from the mid-aortic arch in the direction of

[1] From the Department of Radiology (F. D., Head), Government Hospital, Tel-Hashomer, Israel. Supported in part by the United States Public Heath Service, Grants No. H-3942 and H-3942-C1 (Pathology) and in part by the Jean Getzel Foundation. Accepted for publication in August 1960.

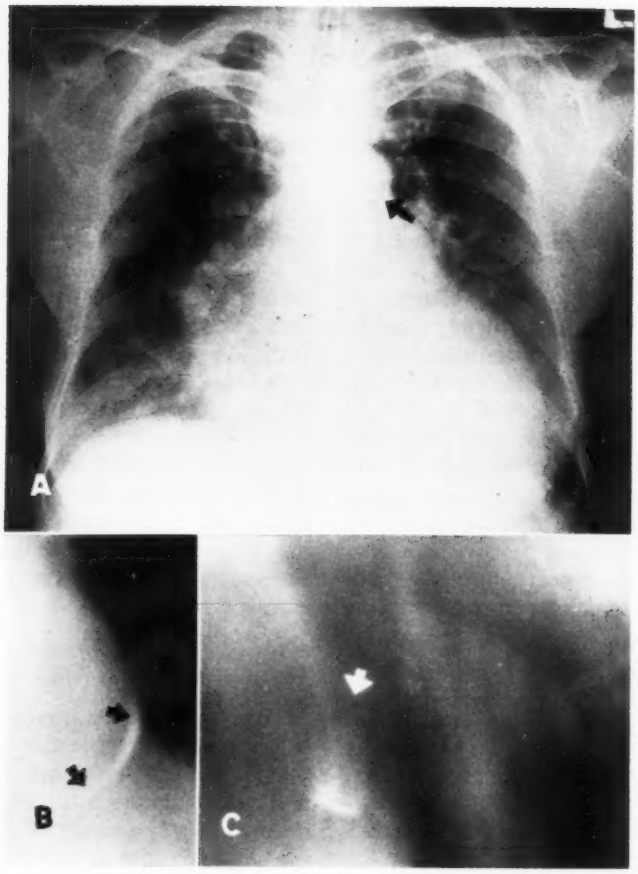

Fig. 1. Calcification of aortic arch in patent ductus arteriosus in a 35-year-old female. A. Postero-anterior chest radiograph. B. Antero-posterior tomogram. C. Latero-oblique tomogram.

the pulmonary artery (Fig. 3, B, small arrows).

Comment: Since localized calcifications in the aortic arch are confined to the segment opposite the shadow of the pulmonary artery, we wondered whether they might be related to and appear as a sequel to the closure of the ductus arteriosus. In order to clarify this point radiological investigation of postmortem specimens was undertaken.

RADIOLOGICAL APPEARANCES IN POSTMORTEM SPECIMENS

"Lateral" Projection: In 24 cases calcification was not seen on the lateral projection (Fig. 4, A; Table I, Column I). Calcification in the obliterated ductus arteriosus as an isolated finding (Fig. 4, B) was seen in 3 specimens (Table I, Column II, a) and was associated with calcification in the aortic wall at the point of its entrance in 7 more (Table I, Column II, ab). A single plaque in the aortic wall confined to the site of entrance of the ligamentum arteriosum (Fig. 4, D) was observed 8 times (Table I, Column II, b). In 20 specimens, two calcium densities were demonstrated in the aortic wall, one at the entrance of the ligamentum arteriosum and the second, more proximally, at the level of the origin of the left subclavian artery; in 7 of these (Table I, Column II, bc) the calcifications were limited to the ventral wall (Fig. 4, F),

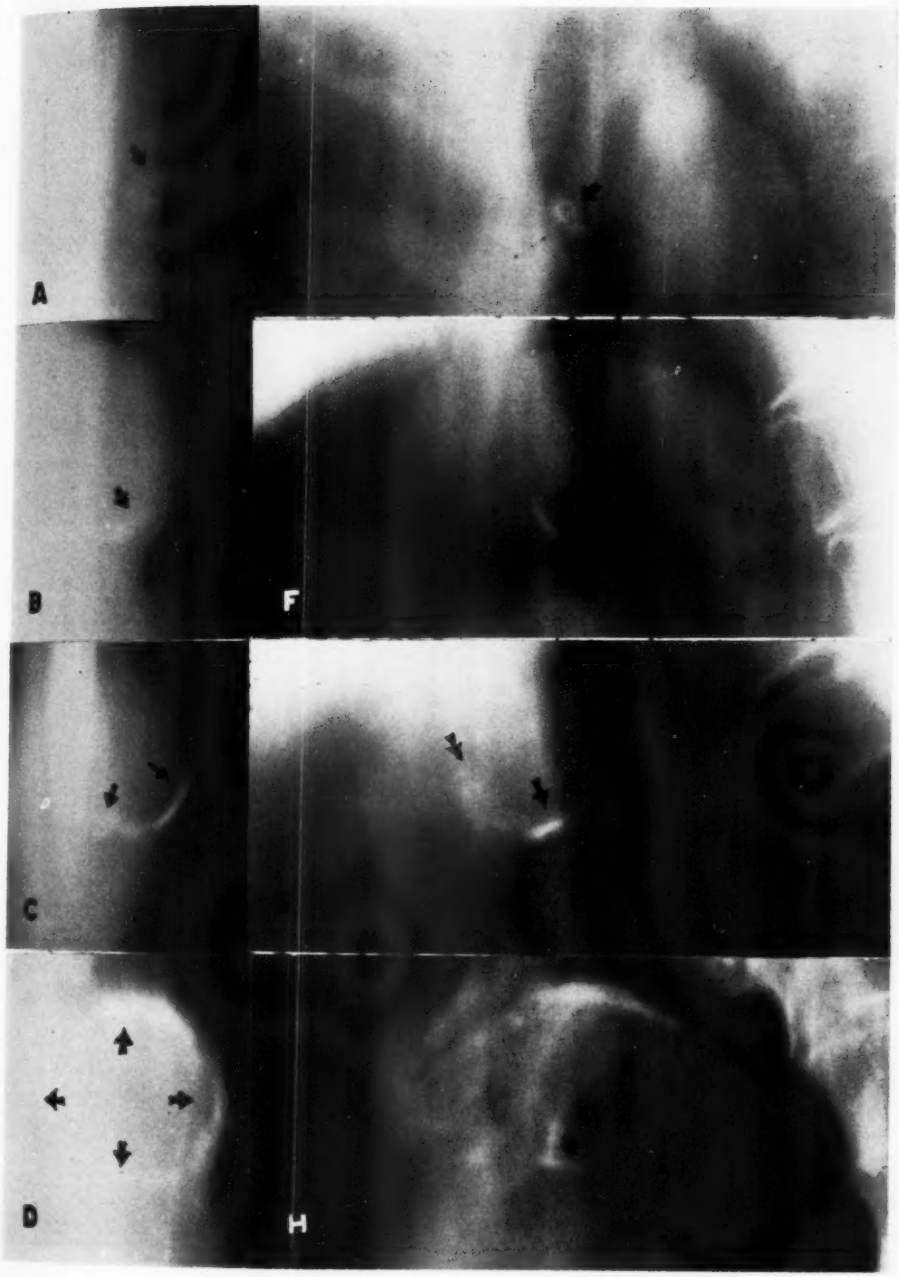

Fig. 2. Tomographic features of calcification of aortic arch. Anteroposterior tomograms showing (A) spot-like, (B) comma-like, (C) sickle-shaped, and (D) circular calcium opacities. Latero-oblique tomograms (E-H) outline more clearly the site of calcium deposition in the ventral wall of the aortic arch opposite the pulmonary artery.

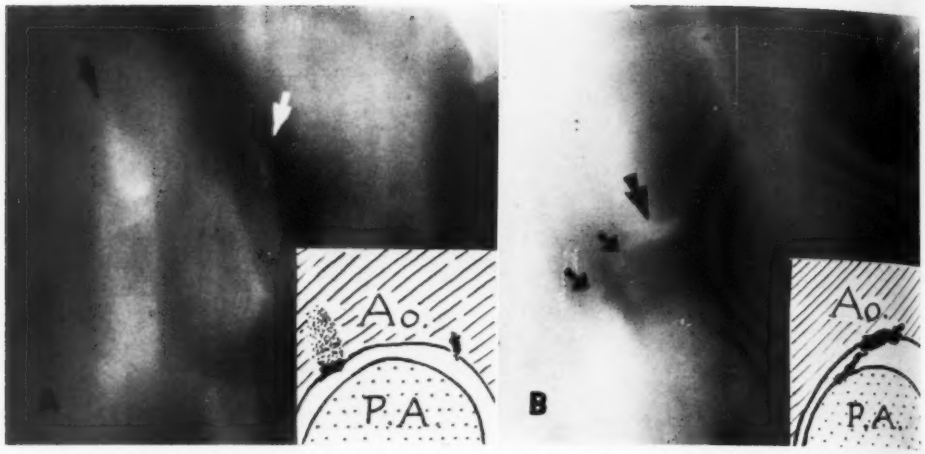

Fig. 3. Tomographic features of calcification of aortic arch (cont.). A. Latero-oblique tomogram showing two distinct calcium densities in the ventral wall of the aortic arch (arrows). B. Latero-oblique tomogram outlines large elongated calcific density within the ventral wall of the aortic arch (large arrow). A thin, linear calcification is seen outside the aorta coursing obliquely from the proximal end of the above opacity to the pulmonary artery (small arrows).

TABLE I: AGE DISTRIBUTION IN DIFFERENT TYPES OF CALCIFICATION OF AORTIC ARCH IN 100 PATHOLOGIC ANATOMIC SPECIMENS

Site of Calcification / Age (yr.)	I	II						III
		a	ab	b	c	bc	BC	
0–9	9	—	—	—	—	—	—	—
10–19	—	1	—	—	—	—	—	—
20–29	1	—	—	—	—	—	—	—
30–39	3	—	1	—	—	—	—	—
40–49	5	1	2	1	—	—	1	—
50–59	5	1	1	3	—	2	3	—
60–69	—	—	1	1	1	4	5	18
70–	1	—	2	3	—	1	4	19
TOTALS	24	3	7	8	1	7	13	37
		39						
		100						

Column I: No calcification; Columns II: Localized calcification (s). a: Ligamentum arteriosum. ab: Ligamentum arteriosum and aortic wall at its entrance. b: Aortic wall at entrance of ligamentum arteriosum. c: Aortic wall at level of left subclavian artery. bc: Aortic wall at location b and c. BC: Location as in bc, but more extensive. Column III: Diffuse calcification.

while larger calcifications, extending to the lateral and dorsal part of the aortic wall (Fig. 4, H), were observed in 13 cases (Table I, Column II, BC). An opacity at the level of the origin of the left subclavian artery as an isolated calcification (Fig. 4, C) was demonstrated once (Table I, Column II, C). Multiple calcifications scattered throughout the aortic arch (Fig. 5) were present in 37 cases (Table I, Column

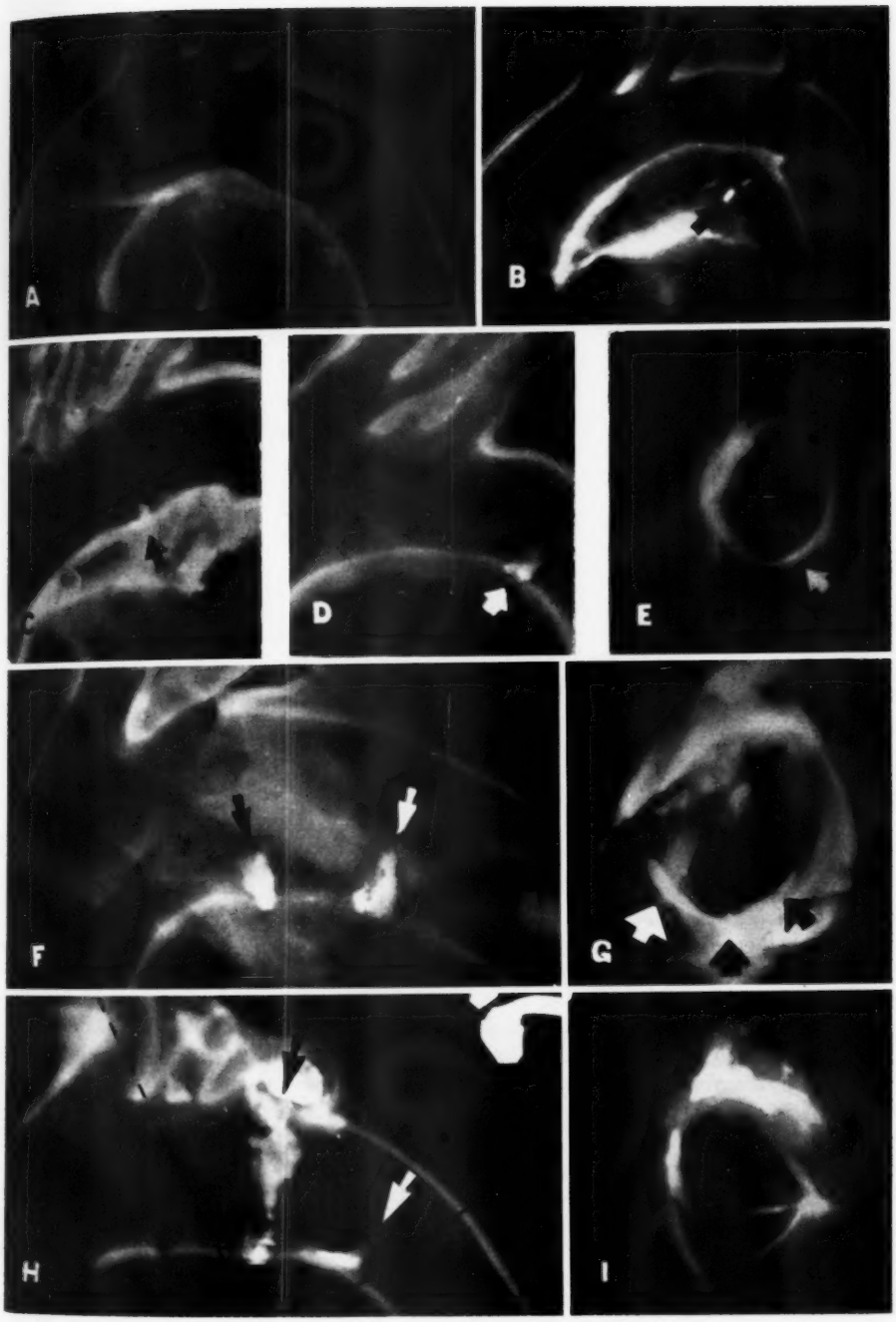

Fig. 4. Radiographs of aortic specimens. A. No calcification. B. Linear calcific opacities in the ligamentum arteriosum. C. Single calcium deposit in the ventral wall at the level of origin of the left subclavian artery. D. Single calcium deposit in the ventral wall at the entrance of the ligamentum arteriosum. E. "Antero-posterior" projection of specimen seen in Fig. 4, D: comma-like appearance of calcium deposit. F. Two calcium deposits in the ventral wall: one (black arrow) at the level of origin of the left subclavian artery and the other (white arrow) situated more distally at the entrance of the ligamentum arteriosum. G. "Anteroposterior" projection of specimen shown in Fig. 4, F: sickle-shaped appearance of calcium deposits. H. Two calcium deposits located as in Fig. 4, F but more extensive. I. "Anteroposterior" projection of specimen seen in Fig. 4, H: circular appearance of calcium deposits.

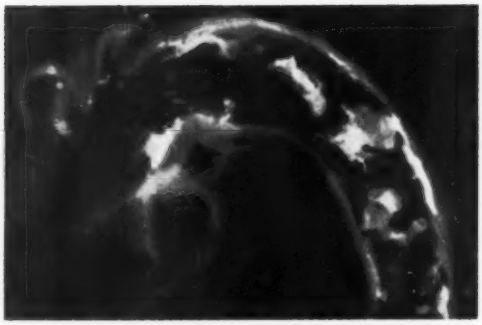

Fig. 5. Radiograph of aortic arch specimen. Multiple calcified opacities scattered throughout the entire arch. Marked narrowing of the aortic isthmus (arrow).

III). In every specimen with multiple calcifications, well defined calcium densities could be identified at the level of the left subclavian artery, at the insertion of the ligamentum arteriosum, or at both. At these two most constant sites, the deposits in the aortic wall were more or less triangular in shape, if small. Larger plaques were elongated, with their long axis perpendicular to the course of the aorta, and irregular in contour. The other, more sporadic calcifications were variable in both size and shape.

"Anteroposterior" Projection: Single or double calcium densities in the aortic wall, of triangular or elongated shape in the "lateral" projection, appeared as thin, curvilinear shadows with comma-like (Fig. 4, E), sickle-shaped (Fig. 4, G), or circular appearance (Fig. 4, I) in the "anteroposterior" projection.

"Open" Projection: No additional information was gained from the "open" projection, although some of the opacities were shown to better advantage in that view. (Fig. 8, D).

The age distribution in the different types is shown in Table I.

Comment: Single calcifications within the aortic wall were located at the insertion of the ligamentum arteriosum and at the level of origin of the left subclavian artery. An examination of the specimens was undertaken in order to clarify the reason for this preferential localization.

GROSS STRUCTURAL CHANGES IN POSTMORTEM SPECIMENS

Depressions: In practically every specimen, irrespective of age, two depressions were seen on the intimal surface of the aorta on its left and left ventral sides (Figs. 6, 7, A, and 8, A). One was located at the level of entrance of the ligamentum arteriosum (white arrow) and the second at the level of origin of the left subclavian artery (black arrow). The depressions are variable in shape and size. Those observed in the ductal area were round, oval, and spindle-shaped, while the subclavian groove was always longish. Atheromatous plaques may fill the depressions completely or in part. On the adventitial surface of the media protrusions were present at the sites of the depressions (Fig. 8, B). When viewed by transillumination, these areas showed increased translucency (Fig. 8, C). In cases in which calcification was outlined on the roentgenogram, the calcium deposition was found to be identical in site with one (Fig. 7, B) or both (Fig. 8, D) of these depressions.

Atheromatous Changes: There was no direct correlation between visible atheromatous changes on the intimal surface of the aorta and calcium-dense opacities demonstrated by radiography.

DISCUSSION

The Nature of the Lesion: The frequency of calcification of the aortic knob has been shown to be related to the frequent deposition of calcium in the left aortic wall (*a*) at the entrance of the ligamentum arteriosum and (*b*) at the level of the origin of the left subclavian artery. Each of these areas showed a depression on the intimal surface, with increased translucency when viewed by transillumination, indicating thinning of the aortic wall. It may be concluded, therefore, that the preferential deposition of calcium in the aortic arch is related to these structural changes.

The more distal of the depressions was described by Winternitz *et al.* (12) as

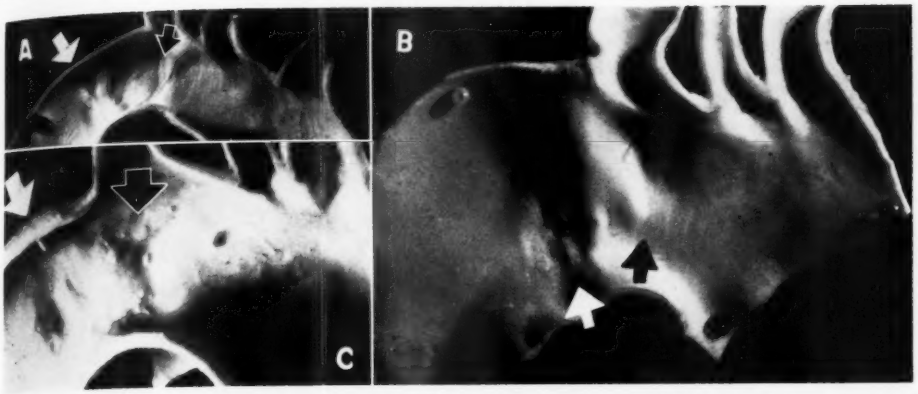

Fig. 6. Anatomical specimens of aortic arch. A. Male, three years. B. Male, twenty-two years. C. Female, forty-four years. Two depressions of various sizes and shapes are discernible on the intimal surface of the left wall: one at the level of origin of the left subclavian artery (black arrow), and the other, situated more distally, at the orifice of the obliterated ductus arteriosus (white arrow). In the radiographs of specimens no calcification was seen.

Fig. 7. A. Anatomical specimen of aortic arch in a 55-year-old female. Intimal surface of left wall: two depressions are seen (arrows). B. Radiograph showing small calcific opacity outlined in region corresponding to the distal dimple (white arrow). A relatively radiolucent area seen in the region of the proximal depression (black arrow).

indicating the entrance of the ductus arteriosus after its closure. He observed as well that the dimple may be the site of a calcareous plaque when the aorta is still without visible signs of arteriosclerosis. Wielenga (11) found this segment of the aortic wall to contain ligamentous, collagen-rich ductal tissue. We may assume, therefore, that the calcification at the aortic orifice of the ductus is most likely the result of a degenerative process confined to the remnant of the sixth embryonic aortic arch within the aortic wall.

The more proximal of the depressions, that at the level of the left subclavian artery, has to the best of our knowledge not been described before. By analogy, it may be assumed to be the residual of a more proximally located embryonic vascular structure, the vestigial fifth aortic arch, with the calcific plaque at this site also the result of a degenerative process.

Little is known of the fifth embryonic aortic arch, a vestigial vessel present in mammalian embryos for only a short period during the first weeks of fetal development (6). There is even disagreement as to its course and connection. Some state that the fifth aortic arch empties into the dorsal aorta (6), while others claim

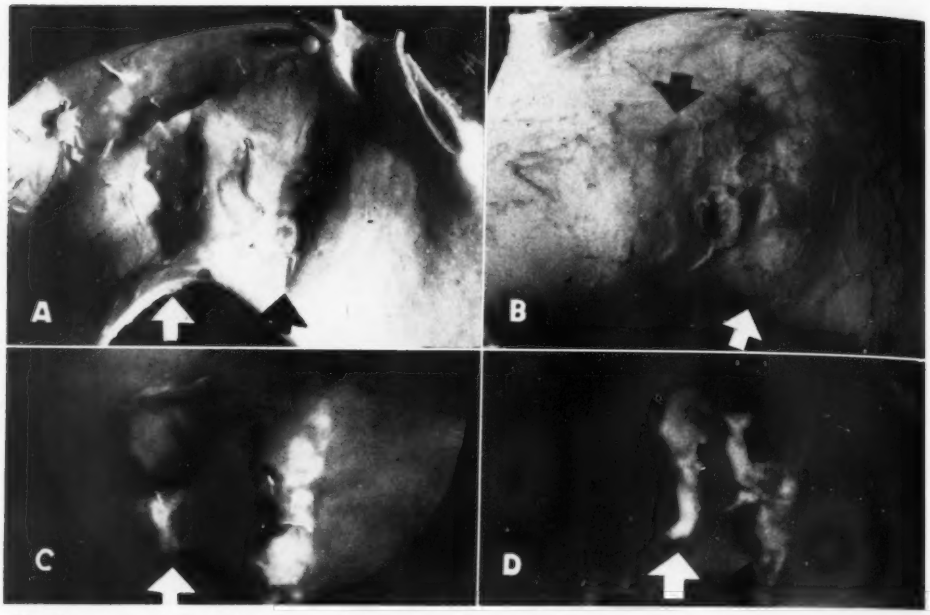

Fig. 8. Anatomical specimen of aortic arch in a 79-year-old female. The black arrow points to structural changes at the level of origin of the left subclavian artery; white arrow to those at the level of insertion of the ligamentum arteriosum. A. Intimal surface of left wall: two depressions. B. Adventitial surface of media: two protrusions. C. Transilluminated specimen: two areas of increased translucency. D. Radiograph, "open" projection: two calcific opacities.

that it terminates in the dorsal portion of the sixth arch (9). Such variance of opinion is probably the result of the unavailability of an adequate number of embryos at this stage of development. Gross examination of the aortic specimens in this study revealed in every instance structural changes on the left wall at the level of the left subclavian artery. If these can be shown to be due to tissue similar to that demonstrated by Wielenga at a more distal level, they may constitute proof that the fifth embryonic aortic arch empties, as do the other fetal arches, into the dorsal aorta. Histologic studies of this segment of the aorta are at present in progress.

Radiologic Considerations: The radiological appearances of calcification of the aortic knob as seen in the postero-anterior chest radiograph are well explained by the preferential deposition of calcium at the two sites described above and the course of the aorta in the chest. As demonstrated in autopsy specimens, calcific opacities of variable shape in the "lateral" projection (Fig. 4, D, F, H) appear as thin, curvilinear shadows in the "anteroposterior" projection (Fig. 4, E, G, I), their extent depending upon the size of the calcium deposits. The frequent double origin of the curvilinear opacity can be readily resolved by tomography in the latero-oblique direction. Small linear calcifications in the obliterated ductus arteriosus (1, 3), which may be outlined radiologically only with difficulty, contribute little to the distinct arcuate density on the routine postero-anterior chest film.

Clinical Significance: Calcified plaques in the aortic knob can appear without visible signs of atherosclerosis. This has been observed previously (12) and is borne out in our autopsy material. It is doubtful, therefore, whether the radiological manifestation "calcification of the aortic knob" should in itself continue to serve as a sign of generalized atherosclerosis of the aorta, as stated in some textbooks (8, 13, 14).

Calcification of the aortic arch is unusual before the fifth decade; in our postmortem series only 1 example was seen before the age of forty. On the other hand, our 2 patients with patent ductus arteriosus showing calcification in the aortic knob were thirty-five and thirty-six years old. Therefore, calcification of the aortic knob in young persons with patent ductus arteriosus may be accepted as a confirmatory sign of that condition, as suggested by Weiss (10). It may be that the peculiar hemodynamic factors associated with the anomaly may fasten the degenerative process within the aortic wall by prolonged, rhythmic wear-and-tear action at the point of entrance of the ductus.

SUMMARY

1. In latero-oblique tomograms of 27 patients showing calcification of the aortic knob in routine postero-anterior chest films, the calcific opacity was almost invariably delineated in the mid-portion of the arch opposite the pulmonary artery.

2. In radiographic studies of 100 consecutive autopsy specimens of the aortic arch, calcification of the aortic knob was found to be the result of single plaques in the aortic wall located either at the entrance of the ligamentum arteriosum or at the level of the origin of the left subclavian artery, or at both sites.

3. In practically every pathological specimen two depressions were found on the intimal surface of the left wall of the aorta: one at the area of insertion of the ligamentum arteriosum and the second at the level of origin of the left subclavian artery. The depressions were found to be identical in site with (*a*) areas of increased translucency when viewed by transillumination and (*b*) calcium-dense opacities in those specimens in which calcium deposition was radiologically demonstrated in the aortic wall.

4. These structural changes correspond to the aortic connections of the sixth and, most probably, the fifth embryonic aortic arches.

5. The significance of the radiologic manifestation "calcified aortic knob" *per se*, for generalized atherosclerosis of the aorta is questioned. Its presence in young persons with patent ductus arteriosus may be accepted as a confirmatory sign of that anomaly.

ACKNOWLEDGMENTS: I am greatly indebted to Dr. H. Ungar, Professor of Pathology, University Hospital "Hadassah," Jerusalem, for his assistance in making this investigation possible and for most helpful suggestions; to the staff of the Department of Pathology of the Tel-Hashomer Hospital, for willing cooperation; and, finally, to Dr. J. Gafni and Dr. H. Bank, of the Departments of Internal Medicine, for their invaluable help in the preparation of this paper. Mr. J. Aidan was responsible for the photographs.

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SUMMARIO IN INTERLINGUA

Calcification del Arco Aortic: Su Relation al Quinte e al Sexte Arco Embryonic

Un Studio Radiologic e Anatomic

Calcification del arco aortic esseva studiate in 27 patientes in qui depositos in le bulbo aortic esseva notate in routinari expositiones postero-anterior e in 100 consecutive specimens necroptic.

In tomogrammas latero-oblique del 27 patientes, le calcificate opacitate esseva delineate quasi invariabilemente in le mesoportion del arco, opposite al arteria pulmonar.

In studios radiographic del 100 specimens necroptic, calcification del bulbo aortic esseva recognoscite como resultato de placas solitari in le pariete aortic, locate al entrata del ligamento arteriose o al nivello del origine del arteria sinistro-subclavian o in ambe iste sitos.

In practicamente omne le specimens pathologic, duo depressiones esseva trovate al superficie intimal del pariete sinistre del aorta: Un in le area del insertion del ligamento arteriose, le altere al nivello del origine del arteria sinistro-subclavian. Esseva trovate que le depressiones esseva identic in location con (*a*) areas de augmentate translucentia in le examine per translumination e (*b*) calcific opacitates in le specimens in le quales deposition de calcium esseva radiologicamente demonstrabile in le pariete aortic.

Iste alterationes structural corresponde con le connexiones aortic del sexte arco embryonic e probabilissimemente etiam del quinte.

Le signification del manifestation radiologic de "calcificate bulbo aortic" in se mesme con respecto a generalisate atherosclerosis del aorta es reguardate como questionabile. Su presentia in juvene subjectos con patente ducto arteriose pote esser acceptate como signo corroboratori de ille anormalitate.

The Use of Parenteral Neostigmine in the Roentgen Study of the Small Bowel[1]

ALEXANDER R. MARGULIS, M.D., and PAUL MANDELSTAM, M.D., Ph.D.

ABNORMALITIES of the small intestine, including tumors, may be clinically unsuspected. Signs and symptoms may be so vague that a small-bowel roentgen examination is not requested by the referring physician (4), and in most institutions this is not carried out routinely following roentgen study of the stomach and duodenum. One reason for this omission is the variability from patient to patient in the time for passage of the barium meal into the cecum, necessitating a large number of films (11).

Procedures have been designed by other workers to facilitate roentgen examination of the small intestine. The "small-intestinal enema" of Schatzki, which entails introduction of barium by a catheter into the duodenum or high jejunum, must be done as a separate procedure (12). Weintraub and Williams (15) reported that in 90 per cent of normal cases an orally administered suspension of barium sulfate in saline will, when followed by ice-cold saline, reach the cecum in less than one hour. This method, however, has not received general acceptance. Many observers believe that it does not afford optimal information because of superimposition of loops of small bowel and a poor ileal pattern.

This paper describes a method for obtaining good visualization of all the loops of the small bowel in almost every patient undergoing upper gastrointestinal examination. The procedure does not affect gastric and duodenal morphology, does not markedly prolong the patient's stay in the x-ray department, and does not unduly increase the number of films. If small-bowel disease is discovered or suspected following this rapid survey, the method can, by more frequent filming and individualization, be adapted to a detailed study. In this way the speed factor can be retained without sacrifice in accuracy.

The technic has been employed during the last ten months in over 3,000 patients having upper gastrointestinal examinations at the Mallinckrodt Institute of Radiology.

PROCEDURE AND RESULTS

Neostigmine methylsulfate (Prostigmin-Roche) is routinely administered to all patients undergoing upper gastrointestinal examination, in order to accelerate transport of barium through the small bowel and to increase intestinal tone. Superimposition of intestinal loops is correspondingly reduced. Half a milligram of the drug (0.75 mg. in patients over 190 lb.) is injected subcutaneously after fluoroscopy of the stomach and duodenum is completed. Films of the small bowel are obtained at intervals thereafter. Patients with a history of recent myocardial infarction are the only group not given neostigmine.

Over 3,000 upper gastrointestinal examinations with neostigmine have been completed, with virtually no untoward results. In no case was medication or cessation of the examination necessary. Five patients complained of severe abdominal cramps. A very few patients complained of nausea, but this cannot be related entirely to the drug. There have been no myocardial infarctions, intestinal perforations, or other serious complications. It is noteworthy, however, that 3 patients died of myocardial infarction during the course of the study: 2 of the group receiving a placebo and no neostigmine died within twelve hours following the examination. The third patient died in the x-ray department after drinking only

[1] From the Department of Radiology and The Edward Mallinckrodt Institute of Radiology, and The Edward Mallinckrodt Department of Pharmacology, Washington University School of Medicine, St. Louis, Mo. Work supported in part by a grant from Hoffmann-La Roche, Inc., Nutley, N. J. Accepted for publication in July 1960.

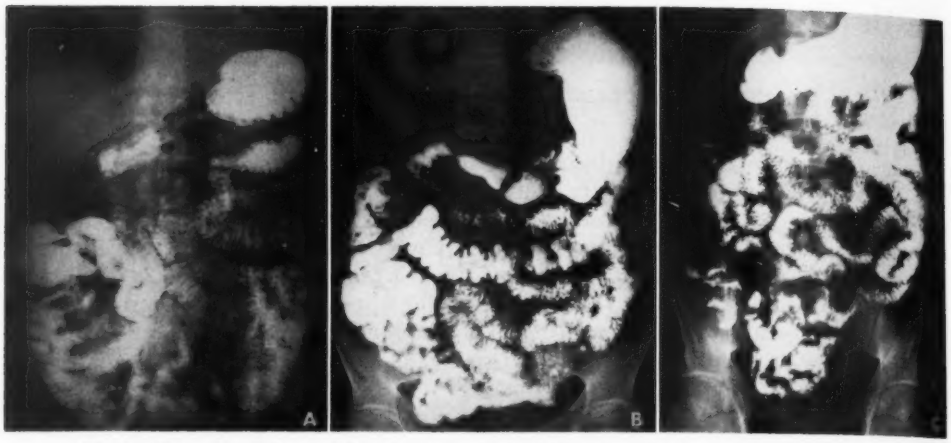

Fig. 1. Examples of the small-bowel pattern obtained following the injection of neostigmine.
A. Ten-minute film showing "excellent" small-bowel pattern.
B. Fifteen-minute film of another patient; excellent small-bowel pattern.
C. Fifteen-minute film of a third patient, exhibiting a "poor" pattern, with the ileum in spasm.

one cup of barium and prior to the injection of neostigmine.

Two separate studies were carried out in order to evaluate the efficacy of neostigmine in the roentgen examination of the small intestine.

1. Pilot Study: One hundred and seven successive unselected patients referred to the Mallinckrodt Institute for examination of the upper gastrointestinal tract received 0.5 mg. (or 0.75 mg. in patients weighing more than 190 lb.) neostigmine subcutaneously after completion of fluoroscopy of the stomach and duodenum. Roentgenograms of the abdomen were obtained thereafter at ten-, fifteen-, thirty-, forty-five-, and sixty-minute intervals. If barium had not reached the cecum by sixty minutes, further films were exposed until this took place. All films, injections, and timing were done by the same chief technician.

The pattern of the small bowel was considered "excellent" if the films demonstrated good valvulae conniventes and good intestinal tone, and if the small bowel could be followed loop by loop in its entirety. A pattern not judged to be "excellent" and yet quite readable and normal was classified as "good." In a number of patients the ileum appeared spastic and narrow and yet within normal limits. This pattern was classified as "poor." Even in this last group interpretation was always possible, since a single delayed film resolved any problem secondary to the spasm induced by neostigmine.

Barium had reached the cecum or beyond within one hour after neostigmine administration in 93 of the 107 patients (87 per cent) as follows:

Patients	*Transit Time in Minutes*
17	10
30	15
27	30
10	45
9	60

In 39 of this group the intestinal pattern was "excellent," in 37 "good," and in 17 "poor" (spastic ileum).

In 14 patients the transit time exceeded sixty minutes. In 1 of these the intestinal pattern was normal, and there was no apparent explanation for the prolonged transit time. In the remaining 13 disordered motor function was demonstrated (4). One patient with hypertension was receiving hexamethonium, a ganglionic blocking agent. Two patients were severely nauseated and vomiting. The other patients with delayed transit times had diabetes mellitus (3 patients), carcinoma of the cecum, neuroblastoma involving the mesentery, chronic lymphatic

leukemia with abdominal node involvement, chronic pancreatitis (proved by biopsy), superior mesenteric artery syndrome (proved by operation) regional ileitis, and chronic ulcerative colitis involving both colon and terminal ileum.

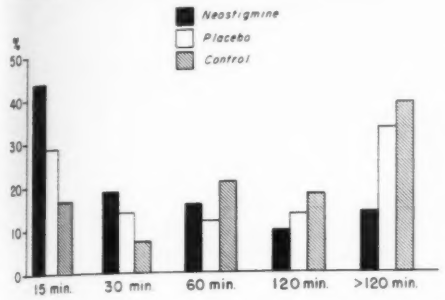

Fig. 2. Time at which barium was seen to have reached the cecum or beyond in the three patient groups of the neostigmine evaluation study. One hundred fifty-three patients received neostigmine, 299 the placebo; 157 were given barium alone and served as a control. The ordinate represents the percentage of each patient group.

In contrast to the investigations of Lönnerblad (11), this study was carried out on a patient population and not on normal subjects. Of the 93 patients of our series in whom the barium meal reached the large intestine within one hour after the injection of neostigmine, many had gastric or duodenal ulcers, neoplasms of the stomach or other organs, gastric or colonic resection, diabetes mellitus, diarrhea, cholelithiasis, etc. It was not deemed advisable to have the patients from this or the following groups return for control studies without neostigmine. Their disease would not be stationary and examination under identical circumstances would be difficult if not impossible.

2. The Effectiveness of Neostigmine in Comparison with No Medication and with a Placebo Injection: In one series of 452 successive patients, 153 were given neostigmine subcutaneously following fluoroscopy of the stomach and duodenum and 299 were given an equal volume (0.5 ml.) of 5 per cent glucose in water. All patients received one injection or the other.

The selection was made by a chief technician, who drew at random the names of the patients from one box and the material to be injected from another. This technician, who tabulated the results of the film reading, was the only person who knew the medication received by each patient. The results were unknown to the three independent readers of the films until the entire study had been completed. For purposes of uniformity, all the medication was administered and the films were taken by this same technician in all phases of the study. The patients did not know what they had received.

TABLE I. TIME FOR APPEARANCE OF BARIUM IN CECUM OR BEYOND

Time (min.)	Neostigmine Group	Placebo Group	Control Group
15	66	86	26
30	28	41	11
60	24	35	32
120	14	39	28
120+	21	98	60
TOTALS	153	299	157

Upon the completion of this series, 157 patients who received no injection were studied. Because it was thought that these patients might become anxious if they learned that others had received injections for the same roentgen examination, and since apprehension has been shown to influence gastrointestinal motility (3, 11), it was only after completion of the placebo-neostigmine series that this third group was examined. The transit time was calculated from the point at which medication had been administered in the other two groups.

In all three groups, neostigmine injection, placebo injection, and no injection, films of the abdomen were obtained at fifteen, thirty, forty-five, sixty, one hundred and twenty minutes and, when necessary, at further intervals until barium had reached the cecum. The results are presented in Table I and Figure 2.

Evaluation of the data in Table I by the Chi Square test reveals that there is less than one chance in a thousand that

Fig. 3. Film exposed sixty minutes following the administration of neostigmine. A balsa wood block with a metallic marker, placed under the right lower quadrant, helps in the study of the terminal ileum.

the observed difference in distribution between the neostigmine and placebo groups is due to chance alone. The possibility that the difference between the neostigmine and control groups is fortuitous is even less. The highly significant difference between the control and placebo groups is also noteworthy (Table II).

Neostigmine is shown beyond doubt to speed intestinal transit. In comparison with the control group receiving no injection, the placebo definitely accelerated propulsion of the barium meal, although it was not nearly as effective as neostigmine. The effect of the placebo points out the importance of psychic influences on intestinal motility (3, 11).

DISCUSSION

Neostigmine methylsulfate acts as a reversible inhibitor of acetylcholinesterase. It protects acetylcholine from enzymatic hydrolysis and allows it to exert its characteristic actions in an intensified manner (6). It is much more selective than physostigmine, being less potent in its effect on the cardiovascular system, exocrine glands, and the iris (6).

The action of neostigmine on the bowel has been well studied (4, 6, 8, 9, 14).

TABLE II: EVALUATION OF THE DIFFERENCES BETWEEN NEOSTIGMINE, PLACEBO, AND CONTROL

	Neostigmine *vs.* Control	Neostigmine *vs.* Placebo	Placebo *vs.* Control
Degrees of freedom (d.f.)	4	4	4
Chi square	49.0	24.0	17.4
p*	<0.001	<0.001	<0.01

*d.f. = 4 Chi Square$_{0.01}$ = 13.277
d.f. = 4 Chi Square$_{0.001}$ = 18.465

* From Fisher and Yates (2).

Following its administration, propulsive waves increase in amplitude and frequency; atony is prevented or diminished; consequently, intestinal transport is enhanced (6, 8). These properties have been utilized in the treatment and prophylaxis of postoperative paralytic ileus (7, 8, 10, 14). The drug has also been used to decrease intestinal gas prior to abdominal roentgenography (1). An intact innervation appears to be necessary (6), for neostigmine fails to increase motility in advanced sprue and other neuromotor disorders of the small intestine, as pointed out by Ingelfinger and Moss (9) and by Golden (4) and confirmed by our own observations.

Neostigmine has been employed in the examination of the small intestine in over 3,000 patients. As the result of these studies the method is now being used routinely in all patients (in the absence of contraindications) having an upper gastrointestinal examination at the Mallinckrodt Institute of Radiology. In the survey study 0.5 mg. of neostigmine (0.75 mg. in patients over 190 lb.) is given subcutaneously following examination of the stomach and duodenum and films are taken fifteen and sixty minutes after the injection and, if necessary, later. Just prior to exposure of the sixty-minute film a balsa wood block (with a small metallic

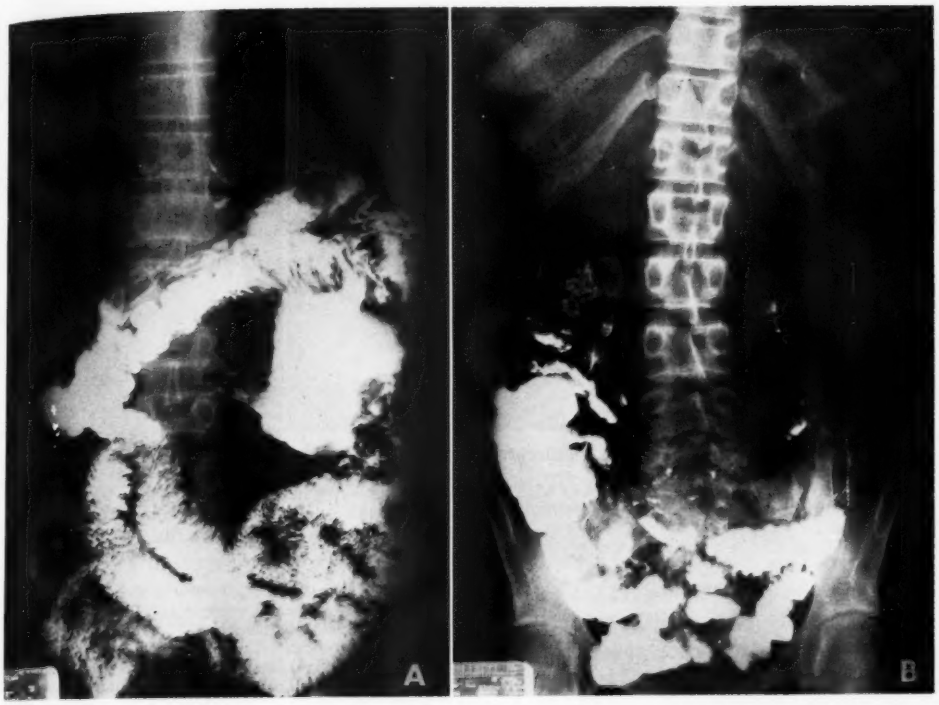

Fig. 4. A. Good demonstration of a lymphosarcoma involving the jejunum. The large mass with a central cavity displaces the surrounding small bowel.
B. Two-hour film in case of sprue. The characteristic morphology of the bowel in this condition is preserved.

marker) is placed under the patient's right lower quadrant for better visualization of the terminal ileum.

A detailed study of the small bowel may be desired in a patient with small-bowel symptoms or as the result of the findings in the survey examination. In this event, roentgenograms are obtained at fifteen, thirty, forty-five, sixty, and one hundred and twenty minutes after administration of neostigmine and at further intervals if necessary. Spot-films of areas of the small bowel or of the ileocecal valve are made, as deemed advantageous by the examiner.

It appears from our observations that tumors and other diseases of the small bowel can be detected satisfactorily by this method. We have diagnosed cases of sprue, lymphosarcoma of the small bowel, regional ileitis, adhesions, involvement of the small bowel by metastatic tumor, etc. Neostigmine does not modify the characteristic morphology and does not alter transit in conditions of disordered motor function.

The contraindications to the use of the drug in the dose range employed are few. Intussusception, volvulus, complete intestinal obstruction, perforation, peritonitis, and recent myocardial infarction have been listed (6, 14).

No cases of neostigmine toxicity have been encountered in this series. We have, however, included atropine in our emergency kit since we started use of the substance.

SUMMARY

A rapid survey method for the examination of the small bowel is outlined. This method takes advantage of the effect of neostigmine on small bowel motility and of the safety of this drug. An evaluation of the effectiveness of neostigmine in this type of examination is presented, based on

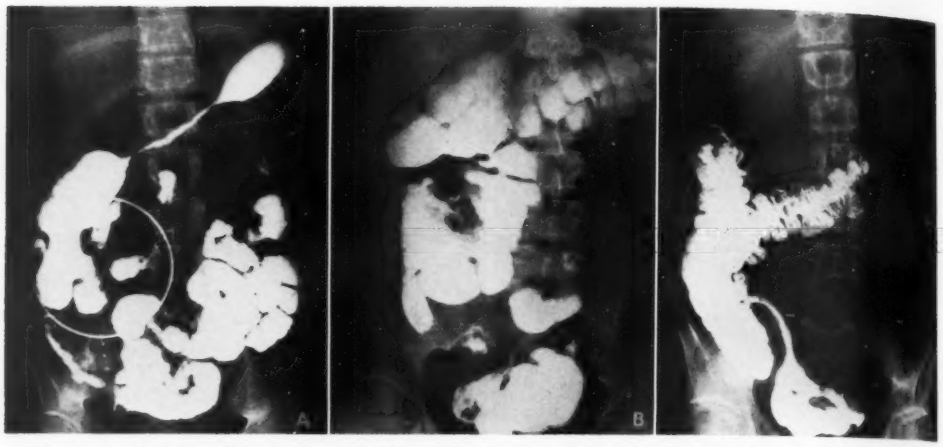

Fig. 5. A. Two-hour film of a patient with chronic ulcerative colitis, showing involvement of a long segment of the terminal ileum.

B. Five-and-a-half-hour film of a patient with regional ileitis, showing involvement of a long segment of terminal ileum, disordered motor function pattern of the ileum proximally, and medial displacement of the cecum by a large abscess.

C. Two-hour film in a patient with terminal ileitis.

experiences in over 3,000 examinations and a special study of a smaller group. This method can, by more frequent filming and individualization, be adapted to the detailed study of the small bowel.

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SUMMARIO IN INTERLINGUA

Le Uso de Neostigmina per Via Parenteral in le Studio Roentgenologic del Intestino Tenue

Le injection de neostigmina immediatemente post le examine fluoroscopic del stomacho o duodeno rende possibile un rapide scrutinio roentgenologic del intestino tenue. Le technica prende avantage del innocentia del droga e de su effecto super le motilitate del intestino tenue. In un studio pilota de 107 casos, le barium migrava usque al ceco o in ultra de illo intra un hora post le administration de neostigmina in 93 observationes.

Comparationes del tempores requirite in le passage de barium esseva effectuate inter 153 patientes qui recipeva injectiones de neostigmina, 299 qui recipeva un placebo, e 157 qui recipeva nulle injection del toto. Esseva trovate que neostigmina, sin ulle dubita, accelera le transito intestinal. In comparation con le gruppo de controlo non recipiente ulle injection, le placebo definitemente accelerava le propulsion del barium, sed de maniera non proximemente tanto efficace como neostigmina. Le effecto del placebo signala le importantia de influentias psychic super le motilitate intestinal.

Neostigmina ha nunc essite usate in le examine del intestinos tenue de plus que 3.000 patientes al Instituto Mallinckrodt de Radiologia. In le absentia de contra-indicationes, illo es usate routinarimente in omne patientes subjicite a examines superogastrointestinal a ille institution. Illo es un methodo de scrutinio general, sed le uso de plus numerose pelliculas, insimul con altere mesuras de individualisation, permitte su adaptation a studios detaliate. Expositiones local del intestino tenue e del valvula ileocecal pote esser effectuate si le examinante reguarda los como advantagiose.

Vertebral Angiography

An Analysis of 106 Cases[1]

ROBERT MONES, M.D.

THE PURPOSE of this report is to evaluate vertebral angiography as a diagnostic tool in neurology. It is based on 106 successful angiograms obtained in a two-year period at the Mount Sinai Hospital in New York. The methods used and the complications observed will be presented, and an analysis of the cases will be given.

TABLE I: VERTEBRAL ANGIOGRAPHY

	1957	1958	Total
Direct method			
Attempts	53	61	114
Successes	29	51	80
Accidental	8	6	14
Retrograde method			
Attempts	34	3	37
Successes	11	1	12
Total successes	48	58	106

METHOD

Because of its simplicity and ease of performance, the direct percutaneous anterior approach of Lindgren (1) was chosen. Before entering the Radiology Department, the patient is given atropine 0.4 mg., and Luminal 200 mg. intramuscularly. Local procaine anesthesia is used on the skin and fascia overlying the transverse processes of the cervical vertebrae. Occasionally a general anesthetic, such as intravenous Pentothal, is necessary in children or uncooperative adults.

A short-bevel 18-gauge spinal needle is introduced 1 cm. from the midline, 3 cm. above the manubrium, and is angled upward for a distance of two or three vertebrae. When the vertebral body is encountered, the needle is moved laterally onto the fascia overlying the transverse processes. It is inserted between the two processes into the foramen transversum until the bony posterior wall of the foramen is felt, and then is slowly withdrawn until blood spurts back. The needle is always pointed laterally to preclude the possibility of its entering the subarachnoid space. The greatest problem is keeping the needle in place while the head and neck are positioned for the lateral and Towne projections. Six cubic centimeters of sodium diatrizoate (Hypaque) has been used routinely for each injection. With this method the amount of anesthesia, the apparatus, and personnel needed are exactly the same as for routine carotid angiography.

Twelve of the 106 patients had retrograde vertebral studies in which a Cournand needle is placed in the right common carotid artery, while the distal carotid artery and the ipsilateral brachial artery are occluded mechanically. Fifteen cubic centimeters of Hypaque is injected and fills the vertebral artery *via* the innominate and subclavian arteries. Although others (Ameli, 2; Schaerer, 3) have had good results with this method, we have had success in only one-third of our attempts, and even in the successful studies the filling of the posterior fossa vessels is not as satisfactory as with the direct method. We therefore use the retrograde procedure only when the right carotid artery has already been cannulated for right carotid angiography.

MATERIAL

This study included all patients in whom vertebral arteriography was done in a two-year period. As shown in Table I, there were a total of 114 attempts at direct vertebral angiography, 80 of which were successful. During this period 14 inadvertent vertebral angiograms were obtained during the performance of routine carotid angiography.

[1] From the Department of Neurology, The Mount Sinai Hospital, New York, N. Y. This study was carried out while the author was a Trainee in Neurology under USPHS Grant 478. Accepted for publication in July 1960.

In 37 patients indirect filling of the vertebral artery by the retrograde method as described above was attempted. In only 12 was the procedure successful.

The indications for vertebral angiography varied. In 20 patients it was part of an investigation of subarachnoid hemorrhage; 9 were suspected of having vascular disease of the posterior cerebral arteries; in the remainder, there was suspicion of either vascular disease or a neoplasm of the posterior fossa. The ages of the patients ranged from eight to seventy-four years. Thirty-nine were in the forty-five to fifty-nine-year range and 35 were over sixty.

COMPLICATIONS

The risk of any diagnostic procedure must be less than its value to the clinician. Table II summarizes the permanent and transient complications seen in the entire series of 128 patients with both successful and unsuccessful direct vertebral angiography. The 37 patients in the retrograde group had no complications.

TABLE II: COMPLICATIONS OF ANGIOGRAPHY

Retrograde studies: 37	0
Direct studies: 128	
Accidental: 14	0
Unsuccessful: 34	
Transient	2
Shoulder weakness	1
Hematoma of the neck	1
Successful: 80	
Transient	11
Occipital lobe dysfunction	5
Dysarthria	2
Dysphasia	2
Dysphagia	2
Permanent	1
Occipital lobe dysfunction (increase in bilateral field defect)	1

In 80 successful direct studies there was one permanent complication: an increase in the organic mental syndrome and visual field defect previously manifest in a sixty-year-old patient who was thought to have vascular disease of the posterior circulation. There were 11 transient complications, 5 of which consisted of bilateral occipital lobe dysfunction evidenced by an organic mental syndrome and bilateral or unilateral visual field defects. All 5 cleared completely within four days. These cases will be described in detail in a separate communication (4). In 6 other patients there were transient episodes of either brain stem dysfunction or cerebral dysfunction, but these also completely cleared within four days.

RESULTS

Of 114 attempts at direct percutaneous angiography, 80 were successful, *i.e.*, either a lateral or anteroposterior projection showed complete filling of the basilar-vertebral arteries and the posterior cerebral artery. Table I is a summary of the results. It is to be noted that in 1958 the percentage of successes in the direct studies was over 80. Approximately one-third of the studies showed abnormalities. Table III lists the diagnostic categories. The classification was made in retrospect after study of the entire record and follow-up history. The clinical course, operative findings, postmortem studies, and radiologic procedures were all considered. Although many of the cases do not have a proved postmortem diagnosis, these classifications give a basis for analysis. All of the "tumor cases" without histologic proof had strong radiologic evidence by air or Pantopaque (5) encephalography for a mass lesion.

TABLE III: DIAGNOSTIC CATEGORIES OF 106 CASES OF SUCCESSFUL VERTEBRAL ANGIOGRAPHY

	Total	Abnormal
Basilar-vertebral artery disease	32	16
Tumors		
Posterior fossa	22	13
Supratentorial	7	2
Carotid artery disease	19	1
Unknown disease	26	3
	106	35

Pneumoencephalograms of most of the patients in the vascular category were obtained. These showed no evidence of a mass lesion. Because of the type of onset, partial recovery in some instances, evidence for vascular disease in other organs, and general clinical course, the diagnosis in these cases was considered to be vascular disease of the brain. A high percentage of occlusive arterial disease demonstrated by

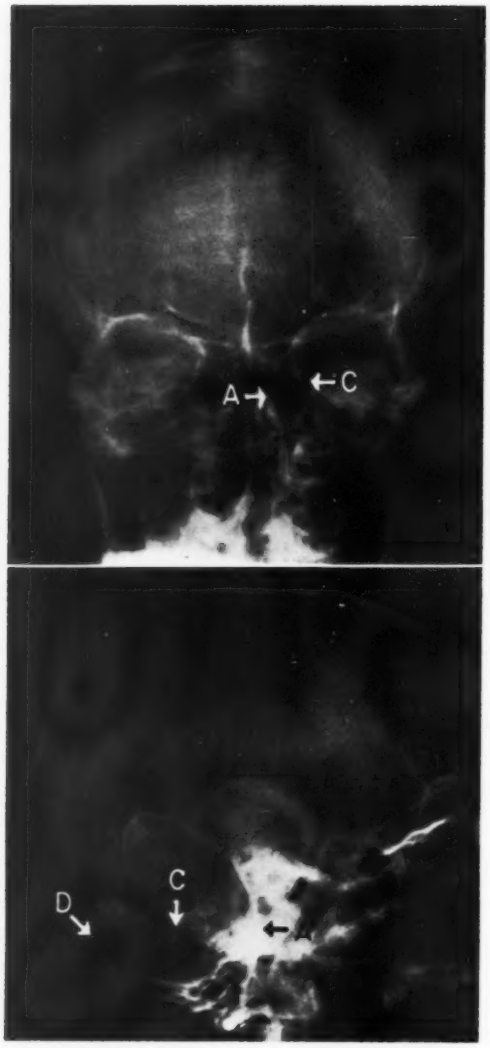

Fig. 1A (above). A 65-year-old man with clinical evidence of acute basilar artery thrombosis. The anteroposterior projection demonstrates good filling of vertebral artery to point (A) distal to branching of posterior-inferior cerebellar artery (C). Postmortem examination showed a complete occlusion of the vertebral-basilar artery just distal to branching of the posterior-inferior cerebellar artery.

Fig. 1B (below). Same patient as in Fig. 1A. Lateral projection showing filling of the vertebral basilar artery to point (A) on clivus. There is filling of the posterior inferior cerebellar artery (C) and evidence of collateral circulation around the cerebellum (D).

Conclusion: Occlusion of basilar artery (proved at autopsy).

Fig. 2. A 60-year-old man with clinical evidence of vascular disease of both occipital lobes, manifested by an organic mental syndrome and cortical blindness.

A right vertebral angiogram shows filling of the vertebral (A) and basilar arteries (B) and poor filling of the superior cerebellar arteries (E). There is no filling of either posterior cerebral artery.

A left vertebral angiogram and left carotid angiogram demonstrated no filling of the posterior cerebral arteries. On pneumoencephalography no evidence of a tumor mass was observed.

Conclusion: Occlusion of the posterior cerebral arteries (no postmortem proof).

TABLE IV: VASCULAR DISEASE

Basilar artery disease (proved or suspected)	32 patients
Abnormalities	5
Aneurysm of basilar artery	2
Arteriovenous anomaly	1
Tortuous, irregular basilar artery	1
Double basilar artery	1
Occlusive disease	11
Basilar artery	6
Vertebral artery	1
Posterior cerebral artery	4
Normal	16

vertebral angiography in this group confirmed that opinion.

A. Vascular Disease: Table IV is a summary of the radiologic findings in 32 patients with proved or suspected arterial disease of the posterior circulation. Abnormal studies were obtained in 16. In 11 cases there was narrowing or occlusion of a major artery. Complete occlusion of the basilar artery with radiologic evidence of a collateral circulation around the cerebellum was demonstrated in 2 cases: in 1 occlusion was proved at autopsy

(Figs. 1A and 1B). The other patient is still alive after a year on intermittent anticoagulant therapy.

In 4 patients there was good filling of the basilar artery, but failure of *either* posterior cerebral artery to fill. In all of these occipital lobe disease was manifested by unilateral or bilateral visual field defects and signs of mental dysfunction and

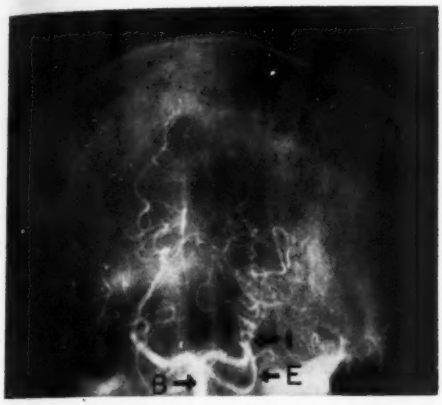

Fig. 3. A 34-year-old woman with sudden nonprogressive right homonymous visual field defect. Vertebral angiogram shows good filling of the basilar artery (B), superior cerebellar arteries (E), and the right posterior cerebral artery (F). The left posterior cerebral artery is filled well until point 1.

A left carotid angiogram demonstrated *no* filling of the left posterior cerebral artery.

Conclusion: Occlusion of the left posterior cerebral artery (no postmortem proof).

it is presumed that they had occlusive disease of the distal basilar artery (Fig. 2). Good filling of at least one posterior cerebral artery was seen in the remaining 102 cases. On anatomical studies it is extremely unusual to find that both posterior cerebral arteries derive their blood supply from the carotid-posterior communicating arterial system (6).

In 4 other patients, both the vertebral angiogram and the ipsilateral carotid arteriogram failed to show filling of one posterior cerebral artery and all 4 had corresponding visual field defects (Fig. 3). In 1 case a segmental narrowing of the right vertebral artery was seen at the branching of the posterior inferior cerebellar artery. This patient had clinical evidence of right dorsolateral medullary

Fig. 4. A 45-year-old man with clinical evidence of a tumor in cerebellum. Vertebral angiogram showing a large midline stain (S) in the region of the superior vermis of the cerebellum. The lateral view shows the basilar artery (B) pushed forward onto clivus. Cerebellar arteries are in normal position. The posterior cerebral arteries filled on earlier films.

Conclusion: Tumor mass in superior vermis (proved meningioma at postmortem examination).

TABLE V: INTRACRANIAL TUMORS

Tumors	30 cases
Posterior fossa tumors	22
Normal angiograms	9
Abnormal angiograms	13
Tumor stain	
Meningioma	1
Metastatic carcinoma	2
Neurinoma of eighth nerve	1
Basilar artery deviation	
Forward to the clivus	3
Backward away from clivus	1
Posterior-inferior cerebellar artery deviation	
Downward	3
Superior cerebellar artery deviation	
Upward	1
Downward	1
Supratentorial tumors	8
Normal angiograms	5
Abnormal angiograms	3
Carotid aneurysm pushing basilar artery backward	1
Posterior cerebral artery deviation	2

dysfunction. Varied abnormalities, such as aneurysm of the basilar artery, arteriovenous anomaly of the vein of Galen, and an extremely tortuous and irregular basilar artery, were seen in 5 cases.

Normal angiograms were obtained in 16 patients with presumed vascular disease. No postmortem examinations have been performed in these cases.

B. Tumors: There were 30 cases with intracranial mass lesions (Table V), including 22 tumors in the posterior fossa;

Fig. 5. A 45-year-old man with a six-month history of slurred speech, ataxic gait, and emotional lability. The pneumoencephalogram showed a moderate hydrocephalus and a deviation backward of the fourth ventricle. The distal basilar artery is deviated backward away from the clivus in a rounded arc (B). A small area of erosion was noted in the superior portion of the clivus (G).

Conclusion: Prepontine mass, probably chordoma (no proof).

7 supratentorial tumors, and a giant aneurysm of the infraclinoid carotid artery which acted as a mass lesion. In 16 of the 30 patients the angiogram was abnormal. Distinct tumor stains in the posterior fossa (Fig. 4), all confirmed by histologic methods, were shown in 4 instances. The basilar artery was closely adherent to the clivus, indicating a mass in the cerebellum or brain stem, in 3 cases; in 2 patients it was deviated backward (Fig. 5) away from the clivus and the posterior clinoids, due in 1 instance to a giant aneurysm of the carotid artery, and in 1 to a prepontine mass (histology unknown) with erosion of the clivus.

In 3 cases the only abnormality seen was in the course of the posterior inferior cerebellar artery (Fig. 6), which took a sharp loop below the foramen magnum from above. This abnormality was shown in 2 other cases with tumor stains. Table VI summarizes the study of the course of the posterior-inferior cerebellar artery. Among the 106 angiograms, 79 adequate lateral views were available for study.

TABLE VI: POSTERIOR-INFERIOR CEREBELLAR ARTERY STUDY

	Total	Tumors
1. Above the foramen magnum throughout	56	9 Posterior fossa 2 Cerebral
2. Starts below the foramen magnum	8	2 Posterior fossa 1 Cerebral
3. Gradual loop below the foramen magnum from above	10	1 Posterior fossa
4. Sharp loop below the foramen magnum from above	5	5 Posterior fossa
	79	20

Four categories are shown and, as is noted, all 5 patients in the fourth category had posterior fossa tumors.

In 9 proved cases of neoplasm of the posterior fossa the vertebral angiogram was normal (Table VII). Variations of the

TABLE VII. ANGIOGRAPHIC FINDINGS IN PROVED POSTERIOR FOSSA TUMORS

	Normal	Abnormal
Cerebellopontine angle	2	1
Cerebellar	3	10
Intramedullary	4	2
	9	13

arteries in the posterior circulation are great, and it is difficult, therefore, to be sure what is abnormal. With more experience the incidence of false negatives will probably decrease. The amount of medium injected is important, as tumor stains may be missed if the vessel filling is minimal.

DISCUSSION

The amount of information gained from vertebral angiography is of value as a positive diagnostic test and as a method to rule out with reasonable certainty certain vascular diseases such as aneurysm, arteriovenous anomaly, or occlusive disease of the arteries.

In this series evidence of vascular abnormality was shown in 16 patients, 11 of whom had occlusive disease of a major artery. We have no other method of making such diagnoses except on clinical grounds, which are generally inaccurate. In many cases of presumed vascular dis-

ease, anticoagulant therapy is considered, although the criteria for its initiation are not clear. It is thought by some clinicians that patients with the clinical history of multiple transient episodes of the brain stem or occipital lobe dysfunction merit anticoagulant therapy. Although articles by Millikan and Siekert (7) indicate excellent results, this view has not been accepted by all observers.

It is suggested that more definitive studies be done in patients before the institution of anticoagulant therapy. In our series, 24 of the 32 patients with basilar artery disease had histories compatible with the syndrome of basilar-artery insufficiency (8): in 10 of these occlusive disease was demonstrated by vertebral angiography; 1 had an aneurysm of the basilar artery; the angiogram was normal in 13. Whether the patients with normal vertebral angiograms represent a different group from those with occlusive disease demonstrated by angiography is not clear at the present time. It is possible that angiography will be of importance in determining which patients will benefit from anticoagulants. There were no angiographic complications of a permanent nature in the 24 cases cited above.

In patients with neoplasm of the posterior fossa or the occipital lobe, vertebral studies are frequently of great aid. There is a large literature, mainly from Scandinavian workers, as to the various manifestations of tumors in this area (9–13). Pneumoencephalography, however, remains the method of choice for diagnostic evaluation of suspected posterior fossa tumors (14). More x-ray studies may be needed because of inability to fill the ventricles, equivocal findings, or a need for further localization. Vertebral angiograms may help by showing: (*a*) tumor stains, which give a good approximation of the position, size, and, at times, the histology of the tumor; (*b*) deviation of an artery, sometimes indicating whether a tumor is intra- or extramedullary; (*c*) the presence or absence of an aneurysm which may act as a mass lesion.

Fig. 6. A 50-year-old man with clinical evidence of an expanding lesion in the posterior fossa. A pneumoencephalogram showed no filling of the ventricular system, with probable cerebellar tonsillar herniation below the foramen magnum.

The vertebral angiogram is normal except for the course of the posterior-inferior cerebellar artery (C), which is seen to take a sharp loop below the foramen magnum from its origin *above* the foramen magnum. All five patients with this configuration had posterior fossa tumors.

Conclusion: Evidence of posterior fossa tumor (meningioma of left cerebellar hemisphere proved at craniotomy).

In our own material, which includes 22 posterior fossa tumors, there were 8 cases in which the veretebral study gave major diagnostic aid to the clinician. In others it was confirmatory or ruled out the possibility of vascular lesions.

In the investigation of the source of subarachnoid bleeding, vertebral angiography is necessary, as approximately 20 per cent of intracranial aneurysms are in the posterior circulation. Occasionally arteriovenous anomalies in the posterior fossa or occipital lobes may be found by vertebral studies. Spatz (15) reported 60 cases of subarachnoid bleeding, in which vertebral angiography was done. There were 8 aneurysms and 8 arteriovenous anomalies in the posterior circulation in his series.

SUMMARY

An analysis of 106 cases with successful vertebral angiography has been presented. In approximately one-half of patients with

neoplasms or vascular disease of the posterior circulation abnormal and, at times, diagnostic vertebral angiograms will be obtained. Only one permanent complication was attributed to vertebral angiography in this series. With care and experience vertebral studies can be done, without undue risk, in patients suspected of having disease in the distribution of the posterior circulation.

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SUMMARIO IN INTERLINGUA

Angiographia Vertebral: Un Analyse de 106 Casos

Le valor de angiographia vertebral como adjuta in le diagnostica neurologic es analysate super le base de 106 successose angiogrammas. Un sol permanente complication esseva attribuibile a iste technica. Octanta de 114 essayos de directe angiographia vertebral succedeva. Le mesmo valeva pro 12 de 37 casos in que le methodo retrograde esseva empleate. Dece-quatro non-planate angiogrammas vertebral esseva obtenite durante le routine de angiographia carotic.

Anormalitates vascular esseva demonstrate in 16 de 32 patientes con provate o suspicite morbo arterial del circulation posterior. Dece-un habeva morbo occlusive de un arteria major. In un serie de 24 patientes con anamneses congrue con un diagnose de insufficientia de arteria basilar, 13 monstrava un angiogramma normal. In 10, morbo occlusive esseva demonstrate per angiographia vertebral. Un habeva un aneurysmo del arteria basilar.

Le casuistica includeva 30 casos de lesiones de massa intracranial: 22 se trovava in le fossa posterior; 7 esseva supratentorial; e 1 esseva un aneurysmo gigante del arteria infraclinoidic con le comportamento de un lesion de massa. In 16 del 30, le angiogramma esseva anormal. In 9 provate casos de tumor del fossa posterior, le angiogramma vertebral esseva normal, sed in 8 casos le studio esseva de grande adjuta diagnostic pro le clinico. Pneumoencephalographia remane, nonobstante, le methodo de election pro le evalutation diagnostic in casos in que tumor de fossa posterior es suspicite.

In le investigation del origine de sanguination subarachnoidic, angiographia vertebral es necessari, proque approximativemente 20 pro cento del aneurysmos intracranial occurre in le circulation posterior.

Conventional Building Materials as Protective Radiation Barriers[1]

E. DALE TROUT, B.S., D.Sc., JOHN P. KELLEY, B.S., and ARTHUR C. LUCAS, B.S.

THE ASSUMPTION is often made in x-ray protection planning that conventional building materials provide no shielding. The exception is concrete which, due to wide use, is accepted by everyone as a satisfactory shield. It is not at all unusual to encounter instances where any material other than lead or concrete is considered unacceptable for wall construction without the addition of a very thin sheet of lead. All materials provide some protection, however, and it would seem advisable to take this fact into consideration in shielding calculations.

Some types of construction involve materials of a heterogeneous nature and the problem of calculating shielding data under such circumstances does not seem to be a simple one. The only solution apparent to us was actually to construct some typical wall sections and make transmission measurements.

The x-ray source used in these investigations consisted of a resonant transformer operating at a nominal frequency of 1,200 cycles, and a grounded anode, beryllium window tube, capable of operation from 70 to 300 kvp at tube currents up to 20 ma. An electronic power source supplied the 1,200-cycle input to the high-voltage transformer. Both kilovoltage and tube current were electronically stabilized and monitored with 0.1 per cent potentiometers having 0.05 per cent reproducibility. Radiation measurements were taken at 70 to 300 kvp, with 0.5 mm. of aluminum filtration up to and including 125 kvp and with 3.0 mm. of aluminum at higher kilovoltages. The filtration was selected to be consistent with that used in connection with the lead attenuation curves in National Bureau of Standards *Handbook 60*, Fig. 3, page 35.

The x-ray unit was provided with a diaphragm which could be adjusted for square or rectangular fields. This diaphragm with its associated light-beam localizer was used to set the field at the front surface of the wall sections.

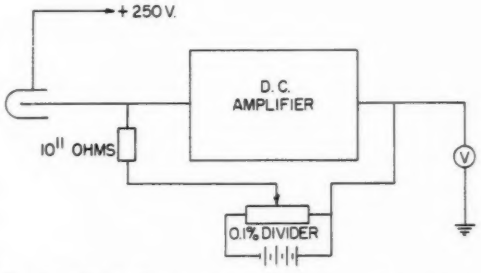

Fig. 1. Block diagram of dose rate measuring system.

Transmission measurements were made with the smallest practicable ionization chambers better to resolve small holes in the wall sections. All dose rate measurements greater than 1 milliroentgen per minute were taken with a Victoreen 25-r thimble chamber modified and connected as shown in Figure 1. For a few of the measurements at low kilovoltage, a 100-c.c. chamber was used. Comparison of the two chambers showed good agreement, both behind the wall sections and in the unattenuated beam. Ionization currents were read with a null system with a 0.1 per cent potentiometer and a D.C. amplifier as a null detector. The system was calibrated against a Victoreen r meter at dose rates sufficiently high to allow intercomparison. The Victoreen r meter had been calibrated at the National Bureau of Standards.

In order to provide data on structures conforming as nearly as possible to that which would be found in actual construction, several trade organizations were asked to provide samples of what they considered to be typical walls. The samples

[1] From the Radiation Physics Laboratory, General Electric Co., Milwaukee, Wisc. Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

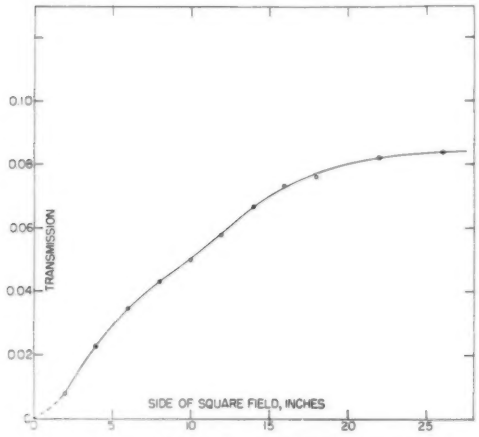

Fig. 2. Effect of field size on transmission through a cinder block wall section.

were 3 feet square and ranged in thickness from a thin gypsum plaster wall to a thick cinder block and Portland cement mortar wall.

The transmission through a thick barrier varies rapidly with the irradiated area. It has been conventional, when deriving shielding data, to use fields of about 1 foot diameter for lead and 3 feet for concrete. These fields are sufficiently large that further increases in size do not greatly influence the resulting measurement.

An example of the effect of field size on transmission for a typical wall section is shown in Figure 2. The transmission rises rapidly as the size of the field is increased to about 18 inches and increases very slowly for fields exceeding this. A 26 × 26-inch field at the face of the wall section was chosen for these studies, since it provided nearly maximum scatter and left a small, unirradiated margin around the periphery of the wall section. The focal-chamber distance used was 72 inches, with the chamber placed 2 inches from the exit surface of the wall section.

The following wall sections were investigated. The identifying numbers will be used in reference to these wall sections throughout the text.

1. Cinder block with Portland cement mortar and 4 × 4-inch ceramic wall tile on both sides.
2. Cinder block with Portland cement mortar on both sides, 4 × 4-inch ceramic wall tile on one side, and 1 × 1-inch ceramic mosaic tile on the other.
3. Cinder block with barium mortar on both sides, 4 × 4-inch ceramic wall tile on one side, and 1 × 1-inch ceramic mosaic tile on the other.
4. Gypsum Pyrobar with Portland cement mortar and 4 × 4-inch ceramic wall tile on both sides.
5. Gypsum Pyrobar with Portland cement mortar on both sides.
6. Two inches of gypsum plaster on metal lath.
7. Two 3/4-inch layers of gypsum plaster on metal lath with a 3 1/4 inch space between layers.
8. Prefabricated steel wall consisting of two layers of 20-gauge (0.0375 inch) sheet steel and 3 inches of Fiberglas insulation.

Cross sections of wall sections 1, 2, 3, and 4 are shown in Figure 3. The mortar in wall section 1 consisted of 1 part Portland cement, 1/2 part lime, and 4 parts sand on both sides of the cinder block, and the section was finished with 4 × 4-inch ceramic wall tile on both sides. The mortar in wall section 2 consisted of 1 part Portland cement, 1/2 part lime, and 4 parts sand on both sides of the cinder block, and the section was finished with 4 × 4-inch ceramic wall tile on one side and 1 × 1-inch ceramic mosaic tile on the other. The different surface finishes in these two wall sections were used in order to detect any possible dependence of the shielding on increased number of mortar joints.

The barium mortar in wall section 3 was composed of 1/2 part Portland cement, 1 part barium powder, and 4 parts sand on both sides of the cinder block, and the section was finished with 4 × 4-inch ceramic wall tile on one side and 1 × 1-inch ceramic mosaic tile on the other.

The radiograph shown in Figure 4 illustrates the heterogeneous nature of the cinder block wall sections. While some of the cavities were filled in the process of assembling the wall sections, there was in

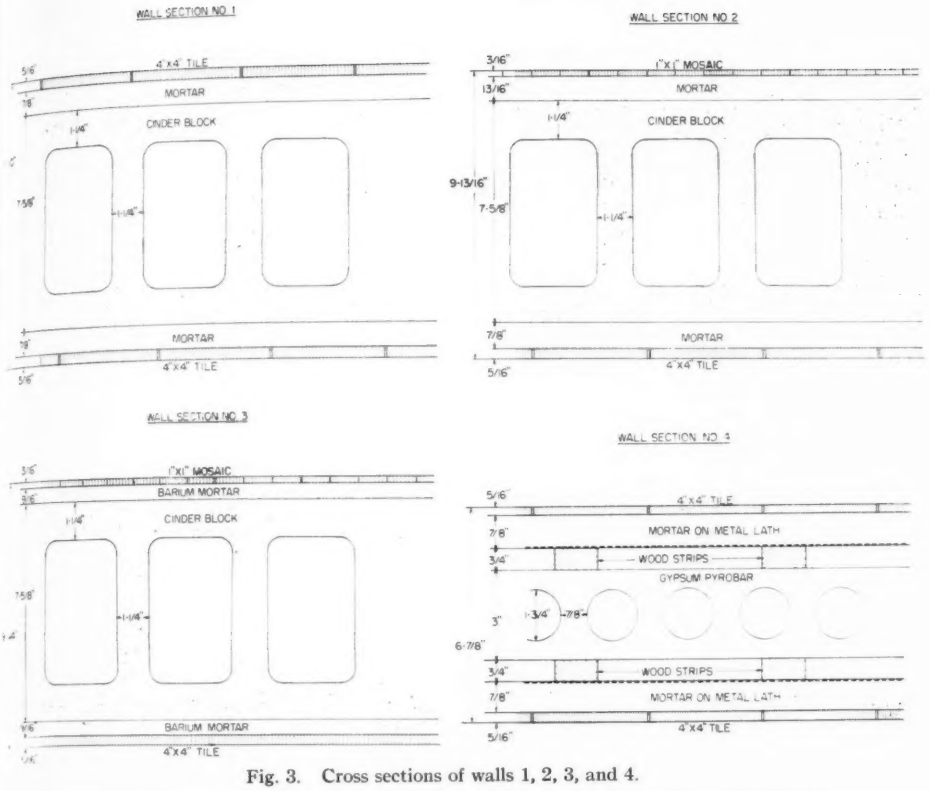

Fig. 3. Cross sections of walls 1, 2, 3, and 4.

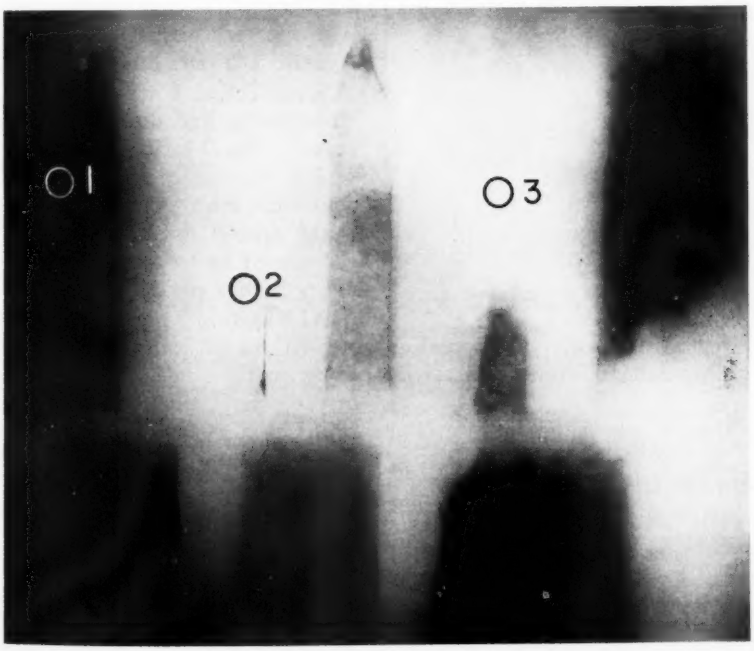

Fig. 4. Radiograph of wall section 2.

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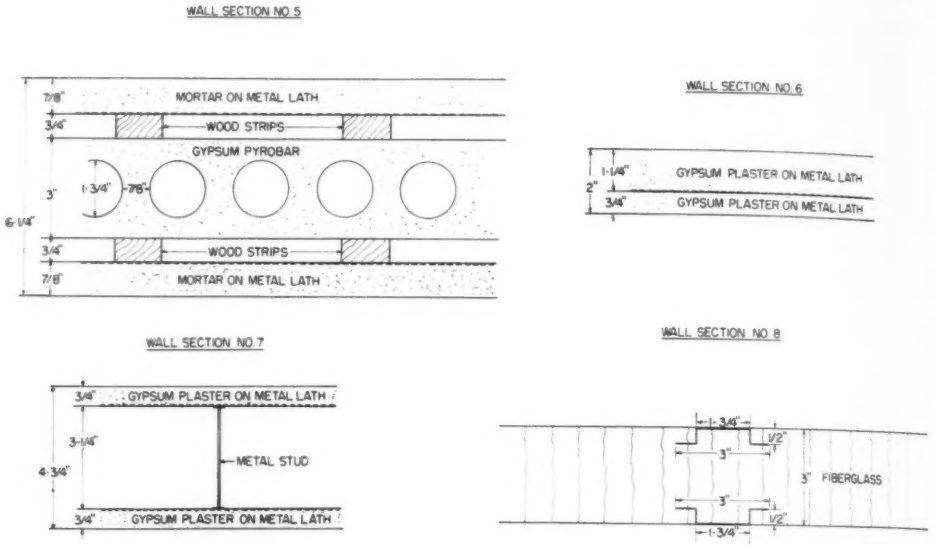

Fig. 5. Cross sections of walls 5, 6, 7, and 8.

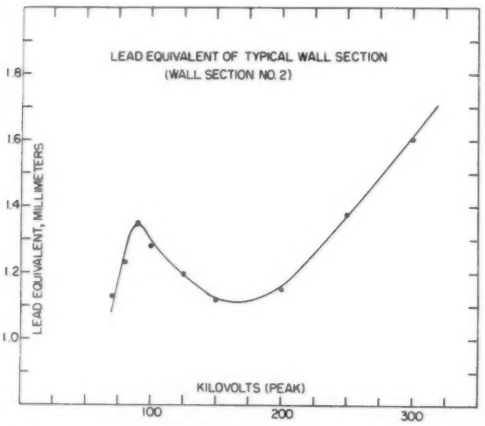

Fig. 6. Lead equivalent of a typical wall section.

all cases a region available corresponding to the anticipated minimum material thickness.

Wall section 4 consisted of Pyrobar blocks laid in mortar with wood furring strips fastened to them with nails. Metal lath was fastened to the wood furring strips and mortar was laid over it. The mortar consisted of 1 part Portland cement, 1/2 part lime, and 4 parts sand. The wall was finished with 4 × 4-inch ceramic wall tile on both sides.

Cross sections of wall sections 5, 6, 7, and 8 are shown in Figure 5. Wall section 5 was made of Pyrobar blocks laid in mortar with wood furring strips attached to them with nails. Metal lath was attached to the furring strips and mortar laid over it. The mortar consisted of 1 part Portland cement, 1/2 part lime, and 4 parts sand.

Wall section 6 was constructed of gypsum plaster laid on both sides of a single layer of metal lath. The plaster consisted of 1 part gypsum and 2 parts sand. The wall section was surfaced with a white lime putty trowel finish. The result may be considered to be an essentially homogeneous section of plaster.

Wall section 7 consisted of gypsum plaster on metal lath attached to prefabricated metal studs. The inner two thirds of the plaster thickness was in the proportion 1 part gypsum and 3 parts sand, and the remainder in the proportion 1 part gypsum and 2 parts sand. The wall section was surfaced with a white lime putty trowel finish.

Wall section 8 was a prefabricated metal wall which the supplier states is available with 1/16- and 1/8-inch lead attached for x-ray purposes. The wall section used was

TABLE I: LEAD EQUIVALENT, IN MILLIMETERS, OF THE WALL SECTIONS STUDIED

Wall Section	Kilovolts (peak) 70	80	90	100	125	150	200	250	300
1									
Min.	1.02	1.16	1.25	1.22	1.13	1.05	1.07	1.23	1.42
Max.	1.32	1.65	1.78	1.75	1.61	1.51	1.55	1.96	2.47
2									
Min.	1.13	1.23	1.35	1.28	1.20	1.12	1.15	1.38	1.61
Max.	1.33	1.70	1.90	1.84	1.52	1.51	1.58	2.00	2.53
3									
Min.	1.90	2.48	2.84	2.69	2.22	1.90	1.78	2.01	2.31
Max.	1.83	2.49	2.97	3.17	2.98	2.68	2.71	3.07	3.77
4									
Min.	0.93	1.00	1.01	0.97	0.89	0.84	0.83	0.87	0.92
Max.	1.11	1.24	1.27	1.20	1.12	1.03	1.03	1.17	1.33
5									
Min.	0.76	0.78	0.83	0.82	0.75	0.59	0.55	0.57	0.60
Max.	0.83	0.92	1.00	0.98	0.89	0.83	0.82	0.88	0.95
6	0.37	0.37	0.40	0.40	0.34	0.29	0.28	0.28	0.27
7	0.36	0.37	0.39	0.40	0.35	0.29	0.27	0.27	0.26
8									
Min.	0.33	0.32	0.32	0.31	0.25	0.21	0.19	0.17	0.16
Max.	0.60	0.58	0.56	0.54	0.43	0.35	0.30	0.28	0.25

TABLE II: CONCRETE EQUIVALENT, IN INCHES, OF THE WALL SECTIONS STUDIED

Wall Section	Kilovolts (peak) 70	80	90	100	125	150	200	250	300
1									
Min.	3.8	3.9	3.9	4.0	4.0	4.1	4.1	4.0	3.9
Max.	...	...	5.2	5.3	5.4	5.6	5.6	5.6	5.6
2									
Min.	4.1	4.1	4.2	4.2	4.2	4.4	4.3	4.4	4.3
Max.	...	...	5.4	5.5	5.4	5.6	5.6	5.7	5.8
3									
Min.	...	...	...	...	7.1	6.8	6.1	5.7	5.4
Max.	...	...	...	...	...	9.0	8.3	7.8	7.5
4									
Min.	3.5	3.4	3.3	3.3	3.2	3.3	3.2	3.1	2.8
Max.	4.1	4.1	4.0	4.0	3.9	4.0	4.0	3.9	3.7
5									
Min.	2.8	2.7	2.8	2.8	2.7	2.8	2.7	2.6	2.3
Max.	3.1	3.2	3.3	3.3	3.2	3.3	3.2	3.1	2.9
6	1.5	...	...	1.6	1.4	1.5	1.5	1.4	...
7	1.4	...	...	1.6	1.5	1.5	1.5	1.4	...
8									
Min.	1.5	...	...	1.3	1.2	1.3	1.1	1.0	...
Max.	2.4	...	...	2.3	1.9	1.9	1.7	1.6	...

made up of 3 inches Fiberglas with 20-gauge steel on both sides.

A radiograph was made of each wall section near its center and was used as a guide for selecting the regions through which measurements were to be obtained. In the case of heterogeneous wall sections, measurements were taken through sections providing the maximum and the minimum shielding. Lead attenuation data were also taken at the kilovoltages selected for the wall section transmission measurements. The transmission data for the wall sections were converted to lead equivalents and also, by the use of previously published data, to concrete equivalents.

A plot of lead equivalent against kilovoltage for a typical wall section is shown in Figure 6, and a plot of concrete equivalent against kilovoltage for the same wall section in Figure 7. The high maximum in the lead equivalent near 100 kvp is due to the minimum absorption encountered at the K absorption edge of lead.

Table I shows the lead equivalent for the

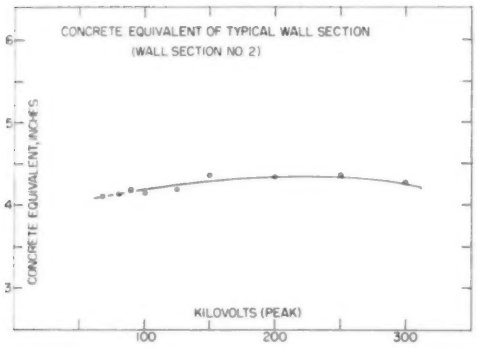

Fig. 7. Concrete equivalent of a typical wall section.

thickest and thinnest regions of each of the wall sections at the selected kilovoltage. Table II shows the concrete equivalent for the same regions at the same kilovoltages. Some vacancies exist in this latter table, since sufficiently extensive concrete attenuation data were not available. These vacancies do not represent serious omissions, however, as the concrete equivalent does not vary rapidly with kilovoltage, and for most purposes extrapolation or interpolation would be satisfactory.

Table III shows a comparison of the actual thickness of the thinnest portion of each wall section with the concrete equivalent measured through that portion. The equivalent concrete thickness is, with the exception of the section incorporating barium mortar, just a little less than the actual thickness. Table IV, however, shows the concrete equivalent of the thickest portion of the wall section to be much less than the actual thickness. This would lend support to the usual practice of assuming the minimum thickness of the wall section for shielding purposes.

TABLE III: CORRELATION OF MINIMUM SECTION THICKNESS WITH CONCRETE EQUIVALENT

Wall Section	Minimum Thickness, in.	Minimum Concrete Equivalent—150 Kvp, in.
1	4.9	4.1
2	4.6	4.4
3	4.1	6.8
4	4.0	3.3
6	2.0	1.5
7	2.0	1.5

TABLE IV: CORRELATION OF MAXIMUM SECTION THICKNESS WITH CONCRETE EQUIVALENT

Wall Section	Maximum Thickness, in.	Maximum Concrete Equivalent—150 Kvp, in.
1	10	5.6
2	9.8	5.6
3	9.2	8.3
4	5.9	4.0

The weight per square foot for each wall section determined by weighing the entire section and dividing by its area is shown in Table V, along with the weight per unit area of the concrete equivalent of the thinnest portion of the wall section. The good correlation between the actual weight and the equivalent weight is significant in that the use of the heterogeneous barrier with its greater structural stability does not result in a greater overall weight than would result from using a thinner, homogeneous concrete wall.

TABLE V: CORRELATION OF AVERAGE WEIGHT OF THE WALL SECTION WITH THE WEIGHT OF ITS CONCRETE EQUIVALENT

Wall Section	Average Weight, psf	Weight of Minimum Concrete Equivalent, psf
1	68.5	60
2	69	65
3	63.3	100
4	45.4	48.5
6	19.3	22
7	18.0	22

Figure 8 shows a radiographic room presenting typical shielding situations. The uncontrolled area adjacent to the equipment requires the maximum shielding which would be needed in such an installation. The thickness of lead which would have to be added to a particular wall when using the various types of construction is shown in Table VI.

While the wall sections described here may be typical in many instances, modifications may exist due to local preferences and conditions. With this in mind, samples of the various components of the sections

TABLE VI: ADDITIONAL MILLIMETERS OF LEAD REQUIRED IN TYPICAL RADIOGRAPHIC ROOM PROTECTION WITH CONVENTIONAL WALL MATERIALS
(150 kilovolts, peak; 200 milliampere-minutes per week; room size 15 × 15 feet)

Room Wall	Wall Section Number								
	None	1	2	3	4	5	6	7	8
A	0.1	None	None	None	None	None	None	None	None
B	0.1	None	None	None	None	None	None	None	None
C	1.2	0.15	0.08	None	0.36	0.61	0.91	0.91	0.99
D	2.2	1.15	1.08	0.30	1.36	1.61	1.91	1.91	1.99
E	0.4	None	None	None	None	None	0.1	0.1	0.19
Door	0.1								
Viewing window	0.1 equivalent								

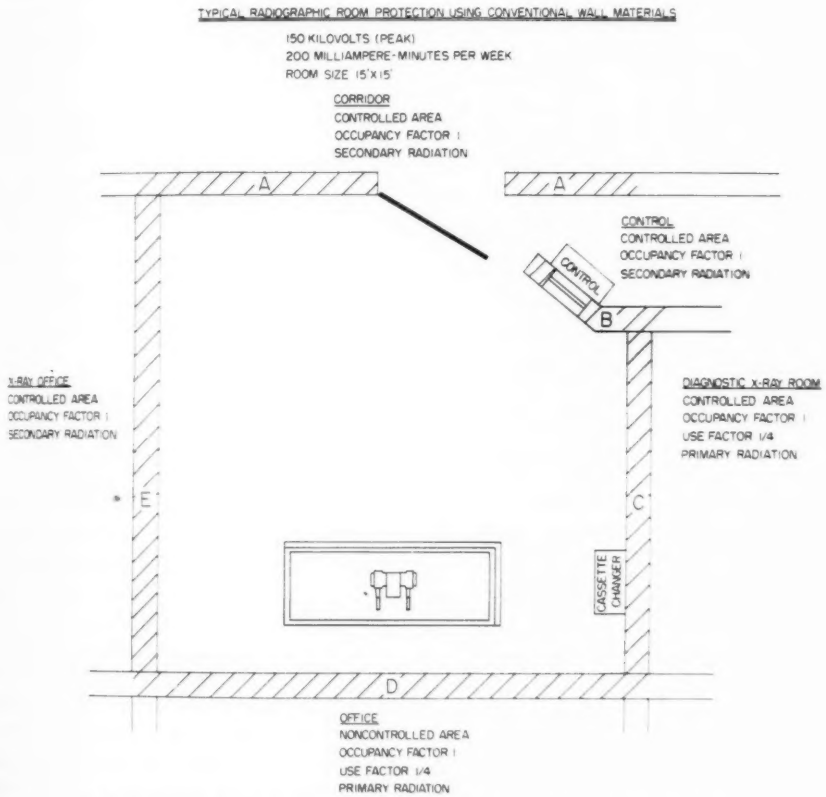

Fig. 8. Typical radiographic room. Refer to Table VI for wall protection.

were taken and their densities measured. Narrow beam attenuation measurements on the small samples indicated that the effective atomic number of all except the barium mortar sample was sufficiently close to that of concrete to allow the use of the broad beam mass attenuation coefficient for concrete in computing changes in attenuation due to slight increases or decreases in the thickness of any one of the component parts of a wall section. Table VII shows the density along with the linear attenuation coefficient and the half-value layer for each of the samples. The attenuation coefficient for barium mortar was calculated from measurements made on wall sections 1 and 3. This value appears to be consistent with that of Hallock

TABLE VII: CHARACTERISTICS OF THE MATERIALS USED IN THE WALL SECTIONS
(150 kvp)

Material	Density, gm./c.c.	μ, in.$^{-1}$	h.v.l., in.
Gypsum plaster	1.63	0.53	1.30
Portland cement mortar	1.54	0.505	1.37
Gypsum Pyrobar	0.94	0.31	2.24
Cinder block	1.49	0.49	1.42
1 × 1-in. mosaic tile	2.35	0.77	0.90
4 × 4-in. ceramic tile	1.92	0.63	1.10
Barium mortar	2.22	2.57	0.27

et al. for barium plaster consisting of 3 parts barium sand, 1 part sand, and 1 part plaster.

The shielding effect of masonry walls is sufficient to provide useful barriers for many applications in the energy range investigated. Walls of conventional building materials should be considered in shielding calculations even though they may not provide all the shielding necessary in a given wall. A considerable reduction in the amount of lead required will usually be effected. The heterogeneity of the sections is not objectionable if protection calculations are based on the minimum effective thickness.

ACKNOWLEDGMENTS: We express our appreciation to: Tile Council of America, Inc., Princeton, N. J., who provided the tile sections: Metal Lath Manufacturers Association, Cleveland, Ohio, who provided the plaster sections: the Mills Company, Inc., Cleveland, Ohio, who provided the metal section. We are also indebted to Mr. Max Deffner, who advised us on the types of construction selected for investigation.

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SUMMARIO IN INTERLINGUA

Materiales de Construction Conventional Como Barrieras de Protection Contra Irradiation

Le autores ha mesurate le protection providite per 7 typos de material de construction currentemente in uso commercial. Un radiogramma esseva facite de cata un del sectiones de muro presso a su centro e esseva usate como guida pro le selection del regiones a transverso le quales le mesurationes debeva esser effectuate. In le caso de heterogenee sectiones de muro, le mesurationes esseva effectuate a transverso le parte que provideva le maximo e le parte que provideva le minimo de protection. Datos de attenuation per plumbo esseva etiam obtenite al kilovoltages seligite pro le mesurationes de transmission per le sectiones de muro. Le datos de transmission pro le sectiones de muro esseva convertite in equivalentes plumbal e—con le utilisation de previemente publicate datos—in equivalentes betonal.

Esseva constatate que le effecto protectori de muros de masoneria es sufficiente pro provider utile barrieras pro numerose applicationes al nivellos de energia investigate. Muros de materiales conventional debe, per consequente, esser prendite in consideration in calculationes de structuras protectori, mesmo si illos non es capace a provider omne le protection que es requirite. Le heterogeneitate del sectiones non es objectionabile si le calculationes es basate super minimos de spissitate efficace.

Malignant Mediastinal Teratoma with Bone Metastases

A Case Report[1]

ARCH W. TEMPLETON, M.D.[2]

A REVIEW of the American radiologic literature failed to disclose any account of malignant mediastinal teratoma. Dann (1) and Present (3) have reported single cases of benign mediastinal teratoma, and Rusby (4) reviewed 245 cases of intrathoracic dermoid cysts and teratomas. The pathology and etiology of mediastinal teratomas are well discussed by Schlumberger (5) and Willis (6). Schlumberger presented 16 cases, 6 of which were malignant. One of his patients showed metastatic invasion of the twelfth thoracic vertebra. In Rusby's series, 12.9 per cent of the teratomas were malignant.

A teratoma is a true neoplasm, composed of multiple tissues foreign to the part of the body in which it arises and possessing the power of progressive growth. According to its behavior or structure, it may be benign or malignant.

Clinically, malignant mediastinal teratomas are seen predominantly in males. The average age of occurrence is twenty-seven years. After onset of symptoms, the average duration of life in Schlumberger's series was five and a half months. Presenting complaints included cough, chest pain, dyspnea, hemoptysis, and engorgement of the neck veins.

Hammarskjöld (2) and Rusby have discussed some of the radiologic features of malignant mediastinal teratoma. The tumor is usually a large, solid-appearing, homogeneous mass located in the anterior mediastinum. With growth it extends superiorly, inferiorly, and laterally, often with localization to one side or the other. The border is usually quite distinct and lobulated. The identification of teeth, bone, or fatty tissues is uncommon. In contrast, benign mediastinal teratomas are typically cystic in appearance, have a smooth, round border, and frequently contain teeth, bone, and fatty tissues. The malignant transformation of a benign tumor is rarely heralded by any sudden increase in size.

CASE REPORT

An 18-year-old white male was first seen at The Henry Ford Hospital on Jan. 8, 1960, because of fullness and pain in the right upper quadrant of about one year duration. He complained also of intermittent severe pain in the sacral region and right upper leg and for the past three weeks had experienced pain in the right lower chest and moderate dyspnea. He denied cough, hemoptysis, or fever.

The patient appeared thin, pale, and chronically ill. The right anterior chest wall was bulging. There were dullness to percussion and râles over the right lung base. Marked voluntary guarding of the right upper quadrant abdominal muscles was noted. The area over the coccyx was tender, but there were no pathologic reflexes or limitation of motion.

Laboratory studies on admission were normal, with the exception of a white blood cell count of 10,400.

Admission roentgenograms (Fig. 1) revealed extensive opacification of the right hemithorax, with only a small amount of aerated lung in the apical region. The mediastinum was slightly shifted to the left. An anteroposterior film of the lumbar spine showed normal architecture and mineralization; destructive lesions were not identified.

Numerous thoracenteses were done, with the recovery of 100 to 500 c.c. of bloody fluid each time. It was thought by some of the observers that the needle seemed to encounter something solid. Cultures of the fluid were negative and no malignant cells were found.

On Jan. 13, a right thoracotomy was done. When the chest was opened, a huge mass was apparent. It was roughly spherical in shape and, though adherent to the chest wall and diaphragm and closely applied to the lung, it was freed from these structures and shown not to arise from them. A pedicle attached the tumor to the anterior mediastinum and was ligated. After decortication of fibrous material, the lung re-expanded quite well. No known tumor was left behind.

The pathologist described the tumor as weighing 1,800 gm. and measuring 19 × 12 × 10 cm. It was

[1] From the Henry Ford Hospital, Detroit, Mich. Accepted for publication in July 1960.
[2] Resident in Radiology.

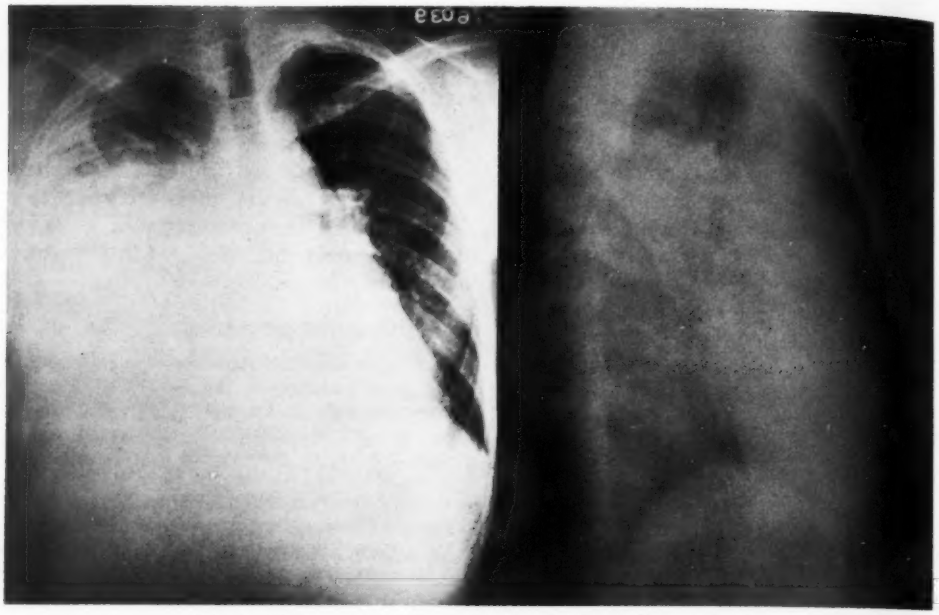

Fig. 1. Preoperative postero-anterior and lateral films of the chest.

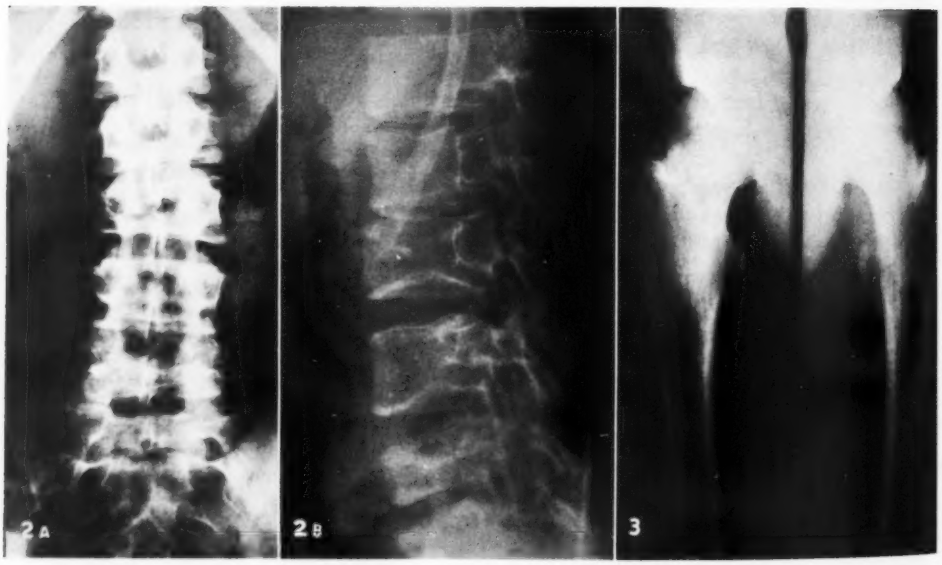

Fig. 2, A and B. Anteroposterior and lateral films of the lumbar spine five weeks after operation.
Fig. 3. Roentgenograms of the upper femurs.

encapsulated and was nodular and cystic in appearance. The cut surface showed areas of cyst formation, solid tumor, and hemorrhage and necrosis. Some of the cysts were filled with a greasy substance. Hair was the only tissue definitely identified.

Microscopically there were numerous areas of typical and atypical gland-like structures. Small mucous glands in a loose fibrous stroma were seen along with many irregular structures that were lined by columnar, transitional, and stratified epithelium. Definite foci of cartilage, smooth muscle, fibrous connective tissue, and loose fibrillar stroma resem-

bling nervous system tissue were identified. The cells making up the irregular glandular areas had large, hyperchromatic, bizarre nuclei. In yet other areas the atypical cells formed solid sheets of tumor. The diagnosis of malignant teratoma was established, with elements of both adenocarcinoma and squamous carcinoma.

Two weeks after discharge the patient was seen in the clinic complaining bitterly of pain in the right hip, worse when sitting, and requiring narcotics for control. Roentgenograms of the lumbar spine (Fig. 2) revealed varying degrees of destruction of the second, third, fourth, and fifth lumbar vertebral bodies, with moderate collapse of the fifth. Films of both legs (Fig. 3) showed a reticular pattern of osteoporosis and small areas of destruction in the upper femurs. On Feb. 18 an open biopsy of the fifth lumbar vertebra was done. The pathologist identified metastatic disease compatible with malignant teratoma.

SUMMARY

An unusual case of malignant mediastinal teratoma with proved metastases to the lumbar spine has been presented.

NOTE: The assistance of Dr. Wm. R. Eyler, Chief of the Department of Radiology, The Henry Ford Hospital, is gratefully acknowledged.

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SUMMARIO IN INTERLINGUA

Maligne Teratoma Mediastinal, con Metastases a Osso

Es reportate un caso inusual de maligne teratoma mediastinal, con metastases al spina dorsal. Le patiente, un adolescente mascule de dece-octo annos de etate, se plangeva de symptomas associabile con le thorace, e roentgenogrammas revelava extense opacification del hemithorace dextere. Le area super le coccyge esseva hypersensibile, sed roentgenographias del spina lumbar monstrava normalitate de architectura e mineralisation. Un grande tumor esseva excidite in thoracotomia, e le diagnose pathologic esseva teratoma maligne con elementos de adenocarcinoma e carcinoma squamose. Cinque septimanas plus tarde, dolores in le coxa dextere esseva sever, e roentgenographias revelava varie grados de destruction del secunde, tertie, quarte, e quinte corpore lumbo-vertebral, con moderate collapso del quinte. Un studio bioptic monstrava morbo metastatic compatibile con teratoma maligne.

A Syringe Heater for Angiocardiography[1]

LESTER L. VARGAS, M.D., and THOMAS FORSYTHE, M.D.

RAPID development of effective surgical methods for correcting congenital and acquired cardiovascular lesions has created a need for precise roentgen demonstration of the cardiac chambers. Increasing experience with angiocardiographic technics has shown the diagnostic advantages of the selective injection of contrast medium through accurately positioned intracardiac catheters or needles. To overcome the resistance to flow in long catheters or needles with small cross-section diameters, mechanical or automatic high-pressure injecting devices must be employed. In addition, adequate opacification requires the use of a concentrated iodinated medium. Seventy per cent sodium acetrizoate (Urokon) has been widely employed in angiocardiography, but several reports calling attention to its nephrotoxic and neurotoxic effects have recently been published (1–4). A fatality following angiocardiography in which 70 per cent Urokon was used led us to abandon this medium in favor of 90 per cent sodium diatrizoate (Hypaque) (5). This preparation has radiographic qualities comparable to those of Urokon but has exhibited less tissue toxicity in the laboratory (4). The 90 per cent solution of diatrizoic salts has the disadvantage, however, of separating into crystalline and fluid fractions at room temperature. It must, therefore, be warmed to body temperature before use. Crystallization within the syringe is likely to occur if, for any reason, the injection is delayed during the study.

The object of this brief report is to describe a simple syringe-heating device which we have designed for use with a mechanical injector. Its purpose is to maintain the radiopaque medium[2] at body temperature before and during the injection.

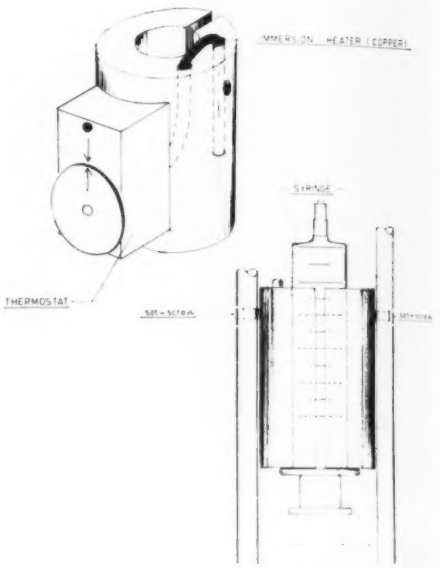

Fig. 1. Drawing of syringe heater indicating manner by which it is attached to injector assembly.

DESCRIPTION OF HEATER

The heater[3] consists of a hollow cylinder which has been machined from standard rod stock aluminum (Figs. 1–3). It is designed to fit snugly around a Lehman[4] 50-c.c. syringe and is slotted along one side to permit visualization of the syringe calibrations. The vertically positioned syringe extends beyond the heater so that any trapped air can easily be seen and eliminated before the injection. The heater is attached to a mechanical injector[5] previously described by Lehman (6). Two

[1] From the Departments of Surgery and Radiology, Rhode Island Hospital, Providence, R. I. R. I. H. Research Project No. 143. Supported by a grant from the John A. Hartford Foundation, Inc. Accepted for publication in June 1960.

[2] Hypaque-M, 90 per cent, used in the preliminary laboratory evaluation of the heater, was generously supplied by Winthrop Laboratories, New York 18, N. Y.

[3] Constructed according to our specifications by Mr. Raymond C. Hill, North Attleboro, Mass.

[4] Obtained from Becton, Dickinson & Co., Rutherford, N. J.

[5] Obtained from Franklin X-ray Corporation, Philadelphia, Penna.

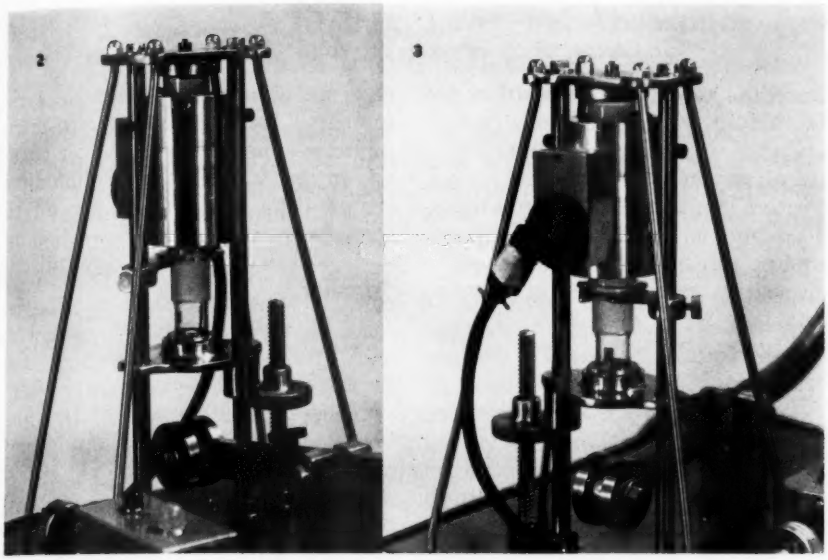

Fig. 2. View of assembly showing slot through which syringe calibration can be viewed.
Fig. 3. View showing temperature control thermostat.

set-screws permit tilting the heater so that the syringe can be easily inserted. A copper electrical thermal immersion element supplies heat by conduction to the aluminum jacket. The capacity of the heater is 75 watts and it operates from a standard house current of 110 volts. A thermostat with a range of 90 to 120° F. controls the temperature of the heater. The thermostat is pre-set at a point required to maintain the solution within the syringe at 99° F. Convection currents within the syringe ensure even distribution of the heat. A pilot light in the circuit indicates when the solution is at proper temperature.

COMMENT

We have found it convenient to fill the syringe with the predetermined amount of 90 per cent Hypaque and to activate the heater before beginning the angiocardiographic procedure. The solution reaches body temperature within ten to fifteen minutes. During this time, the necessary surgery is completed and the catheter is properly positioned within the heart.

If the syringe is accidentally broken during the injection, the heater also serves as protection against scattered glass, confining the fragments which might otherwise result in injury to the patient or operator.

This syringe heater can be constructed at low cost in any well equipped machine shop. It is compact and simple to operate and has the advantage over other syringe-heating devices with hot-water jackets since a circulating pump is not required.

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SUMMARIO IN INTERLINGUA

Un Calefactor de Syringas pro Angiocardiographia

Es describite un simple dispositivo pro le calefaction de syringas, de construction attachabile a un injector mechanic e destinate al uso in le angiocardiographia. Le dispositivo mantene le substantia radio-opac (Hypaque, 90 pro cento) al temperatura corporee ante e durante le injection.

Le dispositivo consiste de un cylindro cave de aluminium in que le syringa es inserite. Un elemento electro-thermic de immersion provide le calor per conduction ad in le jacchetta de aluminium. Le temperatura es regulate per un thermostato, e currentes de convection intra le syringa assecura le uniforme distribution del calor.

A Rapid Screening Method for I^{131} Fat-Absorption Test[1]

LEONARD ROSENTHALL, M.S., M.D.[2]

THE USUAL METHOD for determining small-bowel absorbability of an oral test dose of I^{131}-tagged triolein is to take blood samples three, four, five, and six hours after ingestion. The total blood activity in terms of percentage of administered dose is then compared with normal values. Malabsorption is considered to exist when blood activity falls below the normal range. Impairment of the body's ability to metabolize the absorbed fat is postulated when the blood activity is high and renal function is normal.

Early in our routine clinical use of this test it was learned that, with oral doses of about 20 microcuries, enough activity was present in the blood at the end of three hours to be counted by means of a scintillation detector probe placed against the head. Further, a linear relationship was found to exist between the number of microcuries in the blood and the head counts. This latter finding enables reasonably accurate determination of the percentage of administered dose present in the blood without venipuncture. The examination is terminated in those patients with head counts corresponding to normal levels of absorption at the end of three hours. Venipuncture blood sampling is done at four, five, and six hours in patients with head counts indicating low blood activity at the third hour.

METHODS AND MATERIAL

The material of this study comprises 32 patients (14 male; 18 female), ranging in age from twenty-four to sixty-four years.

Preparation of Patient: Twenty drops of Lugol's solution are administered to the patient the night prior to the test and nothing is taken orally after midnight. Another 20 drops of Lugol's is given the next morning followed by the triolein I^{131} capsule.[3] The patient is permitted to have lunch, provided three hours have elapsed since ingestion of the capsule.

Measurements: The test triolein capsule as it comes from the manufacturer is accurately assayed as to its microcurie content. This is the "administered dose." The capsule, placed in a neck phantom for convenience, is counted at a fixed distance by the same detector probe which is used for head counts. The two-minute capsule count is referred to as "counts administered."

The scintillation detector probe is placed against the side of the head, just above the ear insertion. The net "head count" is the average of the two-minute counts on each side of the head less background, which is determined immediately after ingestion of the triolein-I^{131} capsule. Head counts are taken within a space of five minutes of blood withdrawal.

Two milliliters of venous blood is withdrawn hourly and its activity is measured in a well counter against a standard. The number of microcuries in the 2-ml. sample multiplied by half the blood volume equals the total number of microcuries in the blood. This can also be expressed as the percentage of administered dose. The blood volume is assumed to be 73 ml. per kilogram of body weight or 32.9 ml. per centimeter of height, whichever yields the smaller volume.

Preparation of Graph: Inasmuch as the head count is dependent upon the concentration of activity in the blood and the thickness of the skull, the number of microcuries is plotted against the head count multiplied by blood volume and divided by a head factor. This latter factor is arbi-

[1] From the Chicago Tumor Institute for Radiation Therapy, Department of Radiology, The University of Chicago, Chicago, Ill. Accepted for publication in June 1960.

[2] Present address: Ontario Cancer Institute, Princess Margaret Hospital, Toronto, Ont., Canada.

[3] Raolein (triolein I^{131}) was kindly supplied by the Abbott Laboratories, North Chicago, Ill.

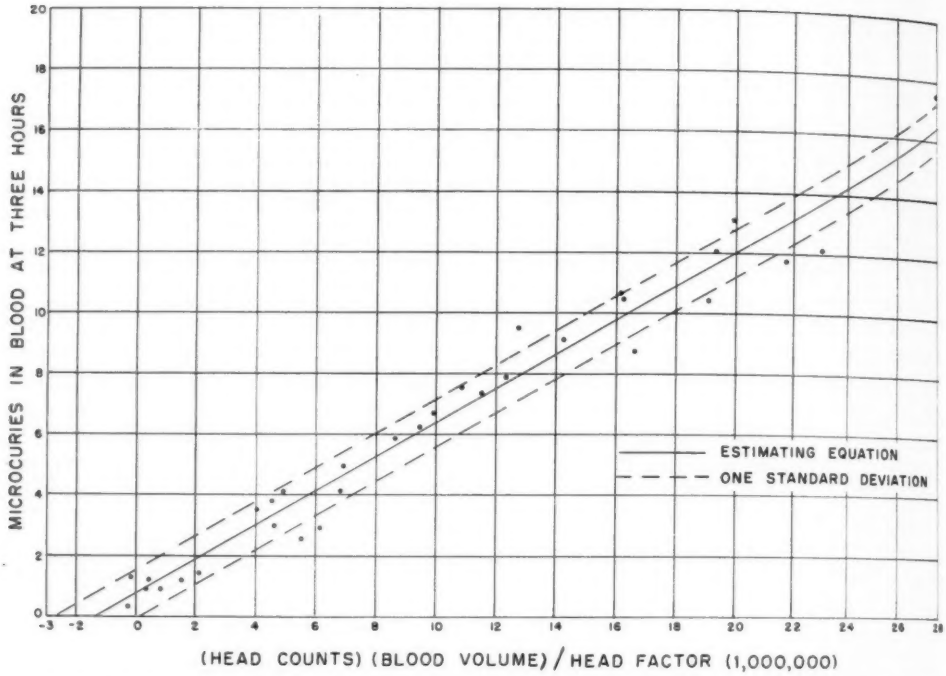
MICROCURIES IN BLOOD AT THREE HOURS
(HEAD COUNTS) (BLOOD VOLUME) / HEAD FACTOR (1,000,000)
ESTIMATING EQUATION
ONE STANDARD DEVIATION

Fig. 1. A plot of microcuries in blood at three hours *versus* head counts multiplied by blood volume, divided by head factor times 10^6. Standard deviation is 0.8 microcuries.

trarily designated as lateral skull thickness, in centimeters, divided by 14 (Fig. 1).

A similar graph is obtained by plotting the percentage in blood of administered dose *versus* the head count multiplied by blood volume, divided by the head factor times the counts administered (Fig. 2). Both graphs are valid only for the three-hour blood sample and corresponding head count.

RESULTS

The standard deviation from the line of regression is 0.8 microcuries and 1.4 per cent respectively. It will be noted that the line does not pass through the intersection of the ordinate and abscissa. This is a result of the decrease in background in three hours by partial absorption of the capsule contents and progression of the remainder further along the small bowel and away from the head. In the determination of the net head counts these changes are not taken into account and only the initial higher background is subtracted from the gross.

DISCUSSION

The linear relationship between blood activity and head counts allows us to screen out normal patients at three hours with reasonable accuracy. Unfortunately, the coefficient of correlation becomes much less for the fourth and fifth hours, as the head counts are influenced by an increasing deposition of radioactive material in the brain substance and no longer parallel the blood concentration.

The average percentage absorbed at three hours in normal subjects with no sign of delayed gastric emptying was found to be 14.6 $\pm$ 2.6 per cent, with a lower limit of 10.1 per cent. Patients with head counts the equivalent of 12 per cent at three hours are therefore considered normal and the test is terminated.

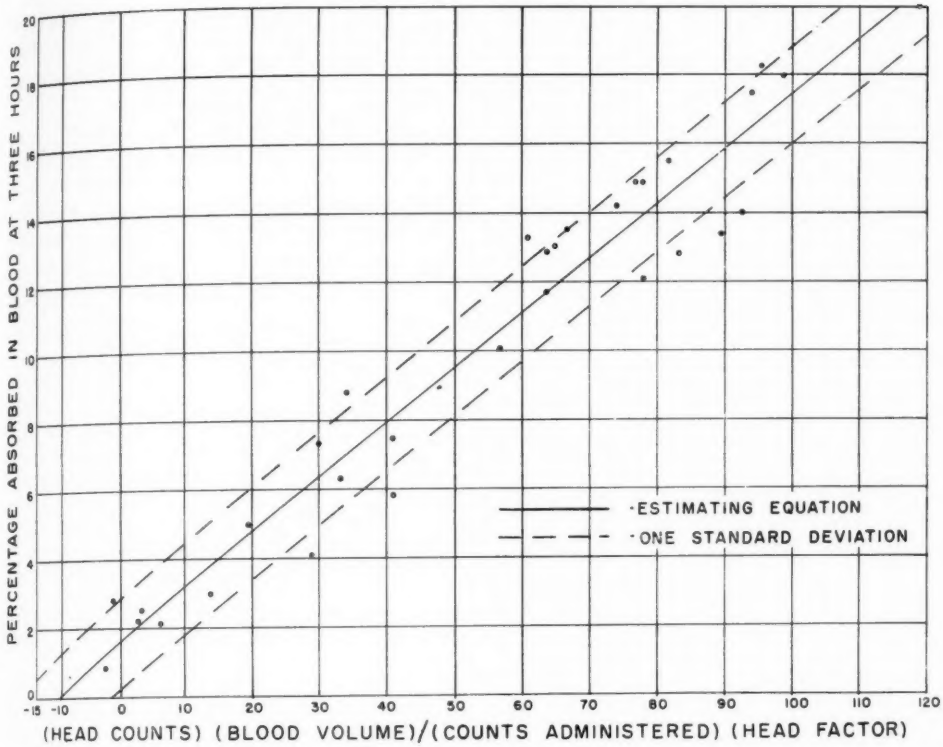
PERCENTAGE ABSORBED IN BLOOD AT THREE HOURS
(HEAD COUNTS) (BLOOD VOLUME)/(COUNTS ADMINISTERED) (HEAD FACTOR)
ESTIMATING EQUATION
ONE STANDARD DEVIATION

Fig. 2. The number of microcuries in the blood at three hours expressed as a percentage of the administered dose plotted against the head counts multiplied by blood volume, divided by counts administered times the head factor. Standard deviation is 1.4 per cent.

SUMMARY

A linear relationship exists between the number of microcuries in the blood, or the percentage absorbed, and the counts detected over the head three hours after the administration of triolein I^{131}. Normal persons can therefore be screened by blood counts at three hours and hourly venipunctures are thus obviated.

The relationship is one that must be individually determined by each laboratory.

ACKNOWLEDGMENTS: I wish to express my gratitude to Dr. J. W. J. Carpender for encouraging the study and for free access to his Isotope Laboratory. Miss Barbara Mikus was invaluable in her performance of most of the technical work.

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SUMMARIO IN INTERLINGUA

Un Methodo Rapide pro Testar le Absorption de Grassia Marcate con I^{131}

Pro determinar le absorbibilitate, in le intestino tenue, de un oral dosage experimental de trioleina con marcation per I^{131}, il es costumari prender specimens de sanguine tres, quatro, cinque, e sex horas post le ingestion. Es concludite que malabsorption es presente si le activitate de I^{131} in le sanguine es infra le limites del norma, sed un defecto in le capacitate del corpore de metabolisar le absorbite

grassia es postulate si le activitate in le sanguine es elevate, durante que le function renal es normal.

Ha essite trovate que il existe un relation linear inter le numero de microcuries in le sanguine (o le procentage absorbite), e le radio-contation obtenite supra le capite tres horas post le administration de trioleina a I^{131}. Contation supra le capite pote assi esser usate pro le detection de subjectos normal, tres horas post le ingestion del agente experimental. Assi venipuncturas a intervallos de un hora pote esser evitate. Infelicemente, le coefficiente de correlation es multo minus marcate post quatro e cinque horas.

Le valores precise in le relation notate debe esser determinate per le laboratorio individual. In le laboratorio del autor, le procentage medie absorbite post tres horas in patientes normal (qui non se distingue per un retardo in le evacuation gastric) es 14,6 ± 2,6. Le limite inferior es 10,1 pro cento.

WORK IN PROGRESS: RADIOLOGIC DIAGNOSIS

The final sessions of the Forty-sixth Annual Meeting of the Radiological Society of North America were given over to brief accounts of new projects in diagnosis and therapy still in the preliminary stages. Following the plan adopted several years ago for the reporting of current work in the field of radiologic physics, these papers are being presented under the heading Work In Progress.

Visual Search Patterns in Roentgen Diagnosis[1]

WILLIAM J. TUDDENHAM, M.D.,[2] and WILLIAM P. CALVERT, M.D.

The surprising frequency of reader error in roentgen diagnosis constitutes a challenging problem, the magnitude of which has been ably documented by Garland (6, 7).

Some avoidable reader error results from our failure *to record* critical shadows. More commonly, however, reader error appears to be due to failure *to perceive* shadows which have been adequately recorded. More precise control of "film quality" than is already possible with existing equipment and materials is not likely, therefore, to increase greatly the accuracy of roentgen diagnosis but greater understanding of the nature of perceptual error may result in significantly improved performance (9).

The factors responsible for errors of perception are, of course, most elusive, but it seems reasonable to assume that they derive, first, from the reader's failure to scan or search the film adequately, and second, from his failure to organize the recorded images effectively.

Despite the fundamental importance of visual search in roentgen diagnosis, there have been, to our knowledge, no objective studies of film-scanning patterns; our concepts of optimum visual search technics are based almost wholly on introspective analysis. Objective studies (3, 4) of visual search patterns in *photographic* interpretation suggest that these concepts may be misleading. It appeared useful, therefore, to undertake an objective study of the visual search technics of radiologists in an effort to elucidate the physiologic processes involved in roentgen diagnosis and to test the validity of present concepts of optimal film-scanning patterns.

Method: Various methods have been described for analyzing search patterns by recording the eye movements of observers (1, 2, 5), but because of its simplicity, the following modification of a technic described by Brandt was ultimately selected for this pilot study. A series of paper roentgenograms of normal and abnormal chests were prepared and presented for interpretation to each of the trained radiologists selected as subjects. The presentations were made with a fixed reading distance in a dimly lighted room. The observers were provided with a spotlight source of variable diameter with which to illuminate the roentgenograms. During practice runs, they were told to move the light as they wished over the surface of the film, but to adjust the source to illuminate, at any instant, an area no larger than they thought was necessary for "comfort and accurate interpretation." No subsequent adjustment of the light source was permitted. The readers were finally told that they would be rated on the *accuracy* of their interpretations; speed and search pattern were not mentioned. The test roentgenograms were then presented and the path of the illuminated spot over the surface of each test roentgenogram was recorded with a 16-mm. motion-picture camera placed behind the subject. The records were subsequently analyzed by reconstructing the geometry of the system and projecting, frame by frame, the processed motion picture film on tracings of the test roentgenograms. The center of the illuminated spot in each frame was marked on the appropriate tracing and these marks, connected in sequence, provided a record of the path of the beam of light, and hence an approximation of the observer's scanning pattern, over the surface of the film.

Observations: A total of 43 tracings representing the visual search patterns of 4 trained radiologists are available for analysis. Comparison of these patterns leads to several interesting observations.

First, a wide inter- and intrapersonal variation in search patterns was recorded. One observer scanned almost all of the roentgenograms with an orderly and consistent pattern; only in a case of obvious gross disease was this completely obscured. A second reader showed reproducible sequences of movements, though his search pattern "overall" was not repeated in the study of successive roentgenograms. A third radiologist displayed no recognizable pattern at all in his examination, while the fourth showed an initial circumferential clockwise motion followed by search without apparent pattern. Since all of the readers were trained in the same department, the wide variations in their search patterns suggest possibly—just possibly—that scanning technics are an individual characteristic not greatly influenced by training.

Second, while the data are insufficient to permit a correlation of accuracy with search pattern, it is interesting to note that the only observer who dis-

played a reproducible search pattern failed to report three significant findings that were noted by the others. Possibly undue concern with maintaining a consistent search pattern was detrimental to accurate diagnosis.

Third, individual readers showed consistent interest in specific areas. One carefully compared the hili and another examined the subdiaphragmatic area with more regularity and more care than did the others. Perhaps this explains the clinical observation that certain readers are particularly "sensitive" to specific types of lesions.

Fourth, all the readers displayed marked nonuniformity in their coverage of the test roentgenograms, showing a conspicuous tendency to return to areas of previously reported disease. Such nonuniformity of coverage may account for much of the reader error noted by Garland.

Fifth, all the readers selected as the smallest "comfortable" illuminated area, a circle subtending a visual angle extending far beyond the zone of macular vision (8). This may reflect a need to "see" shadows in relation to their surroundings if they are to be interpreted or may indicate a role of the peripheral retina in determining the course of visual search (3).

DISCUSSION

Though the experimental procedure employed was attractive in its simplicity, several possible sources of error should be considered. It did not, for example, record the actual point of fixation of the observer's eyes, though it seems fair to assume that fixation lay within the illuminated area of the film, and that the tracings, therefore, provide at least an approximation of the path of the reader's eyes. The system, moreover, permitted the subject relative freedom of motion, and obviated any artefacts arising from the discomfort of rigid head fixation which was formerly necessary for more rigorous recording systems. Again, the conditions of the experiment differed considerably from those of conventional film-reading, but it should be noted that paper roentgenograms read by reflected light are employed on occasion as a diagnostic medium, and that the experimental findings should be applicable at least to this form of roentgen diagnosis. Finally, it is quite possible that the subjects recognized the purpose of the experiment, even though it was deliberately omitted from their directions, and this may have influenced their scanning patterns. If they were trying to conform to the generally accepted ideal of an orderly, reproducible pattern, however, at least 3 of the readers were thoroughly unsuccessful.

SUMMARY

Despite its limitations, this pilot study suffices to suggest that film-scanning is neither so reasonable nor so orderly as we are wont to believe. It serves to define the need for further eye-motion studies in the analysis of problems in roentgen diagnosis: to determine whether accuracy is correlated with search pattern, whether search stratagems can be taught, and whether readers can be effectively selected for specific tasks by analysis of their scanning patterns, and, most fundamental, to study the physiologic factors which govern free search in a complex display such as a roentgenogram.

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High Dose Rate X-Ray Sources with Development of a Lightweight Diagnostic Unit[1]

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A new electron source has radiological significance if it increases the current density available at the x-ray tube anode. The field emission electron source provides an increase of approximately one million in electron current density as compared with the thermal emitter (heated metal) used in conventional tubes. The field emitter has recently been applied in several new x-ray tubes which offer advantages, particularly with respect to high dose rates, high information rates, and miniaturization of the equipment.

X-rays are generated when high-energy electrons strike a metal target. The dose rate is proportional to the electron current; the radiographic resolution depends on the cross-sectional area of the electron beam (x-ray source size). Hence the electron current density (ratio of current to area) is an important radiographic parameter. In fact, it can be shown that the maximum information per unit time that can be obtained radiographically, with an x-ray tube, is dependent on the current density in the electron beam. In turn, the electron beam is dependent on the current density of its source. The very large current density of field emitters thus has direct radiological significance.

The field emitter is a sharp metallic needle, often of tungsten. From a tip of micron diameter it is possible to draw currents of the order of one ampere (10^6 amp./cm.^{2}). Larger currents have been drawn from several needles in parallel. It is not necessary to heat the needle; electrons are drawn from its cold tip in the presence of a high electric field. The field emission mechanism is an old one; it was discovered by R. W. Wood (1) in 1897. Early attempts were made by Lillienfeld (2) and others to apply it to x-ray tubes. Recent success depends on the later demonstration of the aforementioned high current densities (3) and the development of technics for stability and longevity of field emission electron sources (4, 5). Two surveys of the state of the field emission art have been published recently (6, 7).

When the field emitter is heated, one observes a further increase in current density which depends both on the temperature T and electric field F; hence this mechanism has been called T-F emission (8). In this case, current densities of the order of 1,000 amp./cm.^{2} are emitted from more gross metallic structures of simple configuration, such as tungsten wires. Currents up to 2,000 amp. are obtained with T-F emitters in the Fexitron x-ray tubes to be described.

It should be noted that in both field and T-F emission the metallic cathode is conserved; emitted electron current and applied voltage are in phase and their wave shapes are reproducible on a pulse-to-pulse basis. Corresponding advantages are the reliability of the x-ray yield and potentially long tube life. When a square wave voltage pulse is used, the x-ray spectrum corresponds to that of a constant-potential device; however, because of the larger tube current, the x-ray intensity is increased and exposure times may be correspondingly shorter for a given total dose. These cathodes are distinct from the vacuum arc used by Slack (9) in which the metallic electrodes are vaporized to form a plasma from which electrons are drawn. Flynn (10) has studied the properties of arc cathodes: current and voltage are usually out of phase and some difficulties exist with respect to reproducibility and life.

With the high current T-F emission x-ray tube it has been possible to use electronic pulse technics to miniaturize radiographic equipment in a manner

Fig. 1. Self-energized x-ray unit, experimental model.

Fig. 2. Typical chest radiograph taken with experimental portable unit.

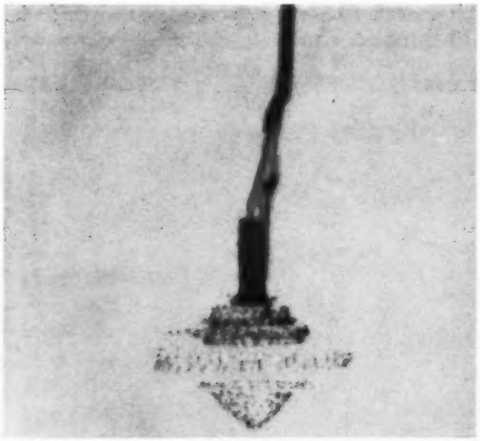

Fig. 3. Radiograph of commercial blasting cap taken with Fexitron PS-300-2000-0.05. Film-to-source distance 54 inches, object-to-film distance 1.5 inches. Blasting cap wall thickness 7 mil copper. Radial velocity of fragments approximately 16,000 ft./sec.

similar to that of visual electronic flash equipment. For example a portable, battery-powered unit weighing 80 lb. (Fig. 1) provides a chest film (Fig. 2) at a distance of 6 ft. at 70 kv. Because of increased tube current (2,500 ma.) the exposure time is short (0.001 sec.); hence motion blur is minimized and the tube may be hand-held, thus avoiding heavy tube mounts. The small x-ray tube is enclosed in a lead shield for operator protection. Like visual electronic flash units, the present x-ray power supply uses a battery source, electrical storage capacitors, and electronic switching. The x-ray tube, of course, requires higher voltage and is less efficient than visual sources; hence x-ray flash units may be expected to be somewhat heavier and larger than their visual counterparts, although much reduced over conventional radiographic equipment.

The foregoing experimental x-ray unit was developed for the Army Medical Service, primarily to establish the validity of this new technic, and therefore embodies some compromises, such as fixed voltage. No difficulty is expected in order further to improve the design to include such features as variable voltage and current and a reduction in the overall size and weight of the unit; work is progressing in these directions. Increased energy storage and higher voltage are also planned and are expected to allow greater penetration, *e.g.*, lateral lumbar. Methods for quick processing of radiographic films are under study.

Due to the microscopic size of the electron source, it has been possible to make a field emission diode tube small enough to be inserted inside a hypodermic needle. While these tubes have yet to be applied to radiology, the possibility exists for developing x-ray tubes which are small enough to be inserted for local therapy or diagnosis.

The unusually high dose rate observed near field emission x-ray tubes is finding applications in radiobiology, radiation chemistry, dosimetry, etc. It has been possible to wrap a thin cylindrical tungsten anode around a mouse which received uniform irradiation during microsecond exposures at the dose rate of 2×10^7 r/sec. and at 300 kv. A miniaturized dosimeter of the ion chamber type was developed for this measurement. Preliminary studies of the biological effect at high dose rates are in progress under support from the U. S. Army Medical Research and Development Command. An improved equipment now under development is expected to provide an x-ray dose of 20,000 in r ten microseconds at 600 kv for small biological specimens, *e.g.*, mice. With further development it appears possible to extract the electron beam through a thin window for the direct electron irradiation of biological material. In this case dose rates in excess of 10^{12} r/sec. are expected at current densities favorable to window life; a typical beam voltage might be 2 million electron volts (2 Mev).

Fig. 4. A typical single-channel flash x-ray system. Stop-motion velocity up to 20,000 ft./sec. Radiography through opaque media of thicknesses up to 3 inches and film-to-source distances up to 20 feet. Available also as a multiple-channel system.

Finally it may be of interest to note the exceptionally high radiographic information rate which has now been well established by use of *T-F* emission x-ray tubes (Fexitrons). Exposures as short as 0.05 microsecond are now available and provide sharp radiographs of small particles (7 mil) traveling at hypervelocities (16,000 fps) as shown in Figure 3. A small compact power supply (Fig. 4) has been developed for this purpose. It applies the very short voltage pulse at 300 kv, 2,000 amp. (600 megawatts peak power). Interchangeable plug-in electri-

cal storage permits variable exposure time in the range 0.05 to 0.5 microsecond. Incidentally, the dose rate near this tube is of the order of 10^7 r/sec.; the x-ray source size is 5 mm.

A 600-kv version of this equipment provides high resolution radiographs through 6 inches of aluminum in 0.2 microsecond. Sample radiographs illustrate the formation of a crater in lead during the impact at hypervelocity (15,000 fps) of a stainless steel pellet (Fig. 5). Shock waves in magnesium and detonation waves in explosives have also been successfully photographed. Incidentally the dose rate near the 600 kv tube is of the order of 10^8 r/sec.

Recently, it has been possible to obtain sequential radiographs of a single high-speed event with fractional microsecond exposures and an interpulse period of one microsecond or more. A simple extension of this technic should provide simultaneous stereographic radiographs.

Progress to date has for the most part depended on the *T-F* emitter and has utilized its corresponding increase of from 10 to 100 in current density over thermal emitters used in conventional x-ray tubes. Experiments are now in progress with field emitters and it appears that in some cases it will be possible to realize nearly the full advantage of its larger increase in current density, *i.e.*, a factor of about a million. One may expect further improvements in dose rate, information rate, and in the miniaturization of x-ray devices. The possibility of unusual biological effects at these dose rates is now being studied.

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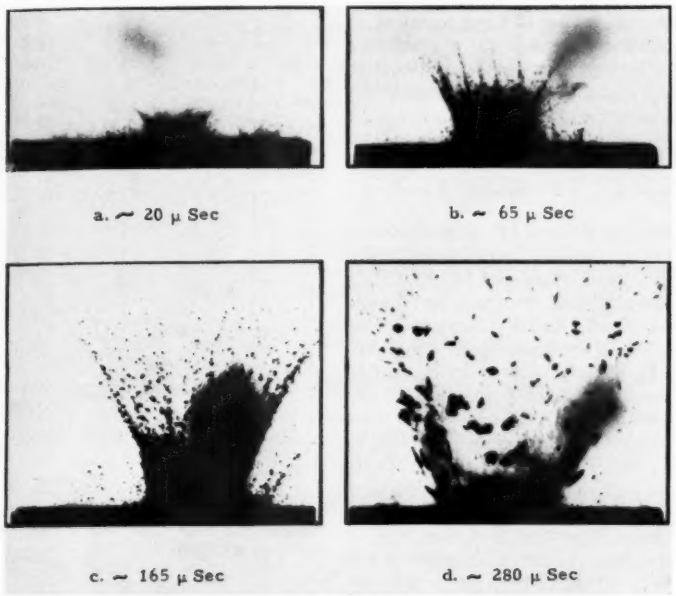

Fig. 5. Fractional microsecond flash x-ray sequence detailing crater formation by steel pellet striking lead block at 15,000 ft./sec. velocity. Times shown are after pellet strikes target. Films taken at 300 kv with Fexitron pulser and T-300-1000-0.2 Fexitron x-ray tube. (Courtesy Ballistic Research Laboratory, Aberdeen Proving Ground)

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Further Experimental and Early Clinical Observations Concerning the Protective Action of Low Molecular Weight Dextran Upon Intravenous Hypaque Toxicity[1]

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Rapid intravenous injection of large amounts of concentrated diatrizoates results in a syndrome which includes the prompt development of systemic hypotension, bradycardia, pulmonary hypertension, and pulmonary edema and hemorrhage. Read (9) demonstrated the simultaneous development of diffuse red blood cell aggregation following such injections, and Sobin (10) has confirmed this finding in man.

Low molecular weight dextran has been employed by Gelin (4) and other Swedish investigators in the prevention and treatment of the red blood cell aggregation seen following burns, fractures, and muscle trauma and by Long and Lillehei (8) in preventing similar aggregations after prolonged cardiopulmonary bypass. Earlier experiments from this laboratory (2) indicated that such premedication approximately doubles the LD 50 and LD 100 of rapidly injected intravenous Hypaque-90 in dogs.

Experimental Studies: Further animal experiments have been carried out in an effort to determine whether other common parenteral agents are also capable of affording this protective action, and to inquire into some aspects of the mechanism of the protection afforded. Mongrel dogs were anesthetized with pentobarbital and subjected to single intravenous doses of 5 c.c./kg. Hypaque-90[3] with the aid of a steel syringe and hand-lever injector. This dose has proved almost uniformly lethal in the unpremedicated animal in our experience (3).

Premedication, with a standard dosage of 10 c.c./kg., was administered intravenously over a two-minute period, following which a ten-minute control period was permitted for equilibration. In addition to the low molecular weight dextran[4] used in the majority of these studies, injections of equal amounts of normal saline, 5 per cent dextrose in water, dog plasma, 6 per cent human serum albumin, and 6 per cent commercial dextran have been evaluated. Aortic blood hematocrit, sedimentation rate, and whole blood and plasma viscosity have been measured and, in addition, the blood pressure, electrocardiogram, respiratory rate and depth, and microcirculation of the bulbar conjunctiva were monitored.

While all of the premedication solutions resulted in some decrease in mortality, none approached the activity of the low molecular weight dextran solution. The component of blood viscosity due to the red cells is here called "apparent RBC viscosity," and was calculated with the measurements of blood and plasma viscosity and the formula:

$$\mu_{RBC} = \frac{\mu_{BL} - (1-h)\,\mu_{PL}}{h},$$

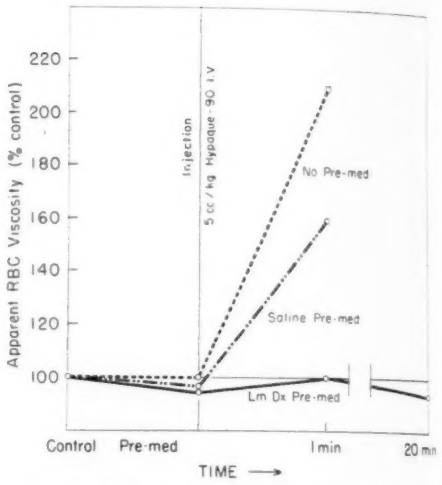

Fig. 1. Effect on apparent RBC viscosity of premedication with saline and with low molecular weight dextran solution.

where

μ = viscosity and
h = hematocrit.

Low molecular weight dextran was capable of maintaining an essentially normal apparent RBC viscosity (Fig. 1). In marked contrast, in the animals without premedication, the apparent RBC viscosity is more than doubled. These observations tend to support the microcirculation studies, which showed formation of red blood cell aggregates in animals not receiving dextran and absence or marked decrease in formation of these aggregates in the dextran-pretreated dogs.

Clinical Observations: To date, we have administered low molecular weight dextran intravenously, in a dosage of 10 c.c./kg. of 15 per cent low molecular weight dextran in D5W, over a thirty-minute period, to a series of 21 patients prior to venous aortography (Table I). It may be noted that the average dose of Hypaque-90 given to this group was 1.39 c.c./kg. There has been no mortality or serious complication in this group. In all but 4, electrocardiographic changes were noted during and just after injection. In most cases, these have been ST- and T-wave depressions, but in 5 instances we have seen the spontaneous development of ventricular premature contractions, and in 2 the development of idioventricular rhythms. In all the patients the changes

TABLE I: PERTINENT DATA CONCERNING 21 PATIENTS WHO RECEIVED LOW MOLECULAR WEIGHT DEXTRAN PRIOR TO INTRAVENOUS AORTOGRAPHY

No.	Age and Sex	Weight (kg.)	Dose Hypaque-90 (c.c./kg.)	Diagnosis	EKG: Post-Injection Alterations
1	68, M	45	1.06	Tortuous descending thoracic aorta	Occasional VPC's
2	54, F	89	1.12	Mediastinal mass; normal aorta	Marked ST-T depression
3	74, M	67	1.12	Abdominal aortic aneurysm	Idioventricular rhythm
4	54, M	87	1.15	Right common iliac occlusion	Slight ST depression
5	66, M	86	1.16	Abdominal aortic occlusion	Marked ST depression
6	76, M	68	1.18	Abdominal aortic aneurysm	No change
7	69, F	66	1.28	Postoperative abdominal aneurysmorrhaphy	Idioventricular rhythm
8	57, M	73	1.37	Abdominal aortic aneurysm	Decreased QRS amplitude
9	39, M	72	1.39	? Left renal mass-normal	Slight ST depression
10	75, M	65	1.40	? Superior mesentery artery thrombosis, normal	No change
11	75, F	57	1.40	Mediastinal mass; normal aorta	Several VPC's
12	63, M	68	1.40	? Left renal mass; normal	No EKG taken
13	65, F	60	1.40	Postoperative aortic homograft	No change
14	67, M	70	1.43	Dissecting aortic aneurysm	Moderate ST-T depression. One VPC
15	47, F	63	1.58	Left subclavian artery thrombosis	Marked ST-T depression
16	26, F	63	1.58	Aneurysm descending thoracic aorta	Moderate ST-T depression
17	49, F	61	1.64	? Abdominal aneurysm; normal	Moderate ST depression. One VPC
18	39, F	55	1.64	Abdominal aortic occlusion	Slight ST depression
19	57, F	60	1.66	Postoperative aortic endarterectomy	No change
20	47, M	58	1.75	? Superior mesentery artery thrombosis; normal	Slight ST depression; occasional VPC's
21	26, F	56	1.78	Aneurysm descending thoracic aorta	Slight ST depression

Average age: 57 years. Average dose: 1.39 c.c./kg.

have been transient and have returned to normal within ten or fifteen minutes following injection. It is our impression in this small series of cases that the quality of contrast seen in the abdominal aorta is superior to that noted in our previous experience with over 200 cases in which no premedication was given and a dose of 0.7 to 1.3 c.c. of Hypaque-90/kg. was administered.

SUMMARY

Premedication with low molecular wieght dextran provides the dog with substantially increased tolerance to large intravenous doses of 90 per cent Hypaque. The evidence suggests that one manifestation of this protection is the ability to maintain a normal apparent RBC viscosity following injections. With this form of premedication Hypaque dosage has been increased clinically without complication or mortality and with some improvement in vascular contrast.

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[2] Post-Doctoral Research Fellow, National Heart Institute, U. S. Public Health Service.

[3] Supplied by Winthrop Laboratories, New York.

[4] Rheomacrodex, supplied by Pharmacia, Inc., New York.

Motility Changes Revealing Esophagogastric Junction[1]

MAJIC S. POTSAID, M.D.,[2] GORO IRIE, M.D.,[3] and NATHAN T. GRISCOM, M.D.[4]

Considerable controversy persists concerning what is strictly normal or abnormal in the distal esophagus and at the cardia. Should it be possible to have a particular observation generally accepted, subsequent definitions of such entities as hiatus hernia, vestibule (1), or ampulla (2), might be more readily and more accurately derived. Common ground for definitions is needed.

Cineradiographic records of 110 unselected fluoroscopic studies of the esophagus were taken from the files and the peristaltic behavior at the cardia was analyzed. The records did not represent an average population distribution. There was a higher than normal percentage of disease, primarily hiatus hernia and lower "esophageal ring" (3–5). There were also patients with varying degrees of tertiary contractions, segmental spasms, or esophageal dysfunction. Carcinoma and stenosis cases contributed little information about peristalsis except that it was absent in the area of involvement. Analysis of each esophageal examination was carried out through projection, single framing, and numerous reshowings when indicated.

In demonstration through peristalsis of the esophagogastric junction, it has been important to record the examination as a satisfactory bolus passes freely into the stomach, particularly unencumbered by the "pinchcock" action of the diaphragm.

Significant and consistent behavior of the cardia shown in this review warrants presentation of the findings as a preliminary report. The nature of peristalsis at the distal esophagus, as demonstrated by barium progressing toward the stomach, has been such that a marked change in the character of the wave occurs at the junction of esophagus and stomach. It has been observed that a peristaltic wave abruptly diminishes in intensity or terminates completely (Fig. 1) at what appears to be the esophagogastric junction (Fig. 2).

In this brief report it has been proposed that certain motility changes reveal the esophagogastric junction in health and disease. The main purpose of this presentation has been to elucidate the phenomenon through cineradiography (6) and to show its helpfulness in determining the anatomic position of the junction of esophageal and gastric musculature. Certain obvious conditions (*e.g.*, hiatus hernia and lower esophageal ring) have been used purely as landmarks to clarify physiologic actions. No attempt has been made at this time to define the relative or absolute norm or to draw a diaphragmatic demarcation above which gastric tissue excursions constitute herniation. More detailed descriptions of esophageal physiology and pathophysiology are left to the future. A method of identifying the esophagogastric junction is the present goal. Common ground for discussion is sought.

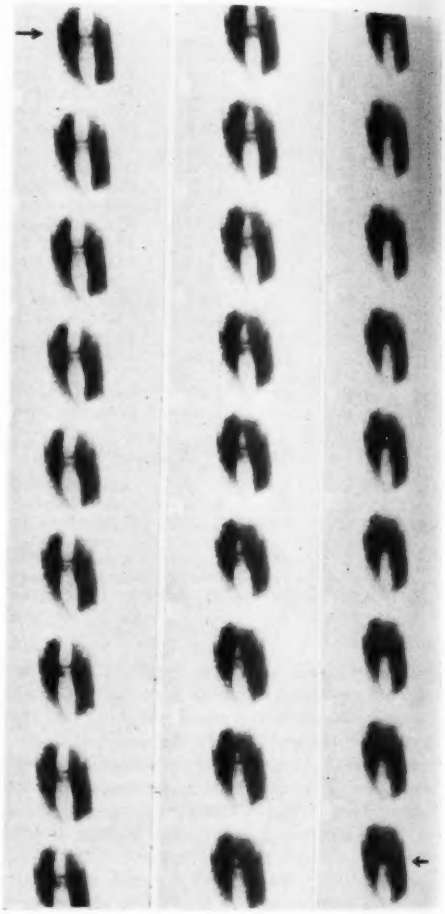

Fig. 1. Termination of peristalsis at esophagogastric junction. Twenty-seven consecutive cineradiographic images from a barium sulfate swallow recorded at 16 frames per second demonstrate the junction (arrows) of esophagus and stomach in a patient with a "ring."

An incomplete review of the literature has shown that many authorities (7–15) focused their attention on peristaltic behavior in the distal esophagus. It has not been generally accepted, however, that the observations described in this report demonstrate in fact the muscle and nerve juncture of the two organs under most or all conditions.

In the present study the esophagogastric junction has been located and the level of peristalsis determined in a group of patients with various pathologic conditions. Questions can be raised as to whether the motility change is due primarily to

Fig. 2. Esophagogastric junction during surgical repair of ring formation. This patient, whose esophageal peristalsis terminated completely at the ring, was shown to have the web-like structure (B) precisely at the mucosal and muscular junction of esophagus (A) and stomach (C).

disease or is truly a reflection of the transition of esophagus to stomach. At this point in the investigation evidence is strong that the esophagogastric junction is revealed by peristalsis independent of pathology!

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Large Field Cineradiography and Image Intensification Utilizing the TVX System[1]

JOSEPH H. WEISS, M.D.

The General Electric Company's TVX system of image amplification appears to offer larger field coverage as well as cineradiography at a radiation dosage level no greater than that necessary for adequate fluoroscopy. The system features a television presentation of a fluoroscopic image (Fig. 1), differing from other forms of image intensifiers in that the pickup or X-icon tube is directly sensitive to the x-rays (1, 2). The image produced by the x-rays is directly converted into an electrical signal which is then amplified on a closed circuit television system. The X-icon tube contains a target coated with lead oxide which is a semiconductor similar to selenium. This target is scanned by an electron beam 30 times per second, then converted into an electrical signal. To reduce the radiation exposure to the patient as well as to attempt to stop motion in each single frame, a pulsed x-ray beam is employed. A unit has been designed which will give 15, 30, or 60 pulses per second with an individual pulse width of 0.5 to 2 millisecond exposures. These short exposures are synchronized with the scanning beam so that a stroboscopic effect is produced. This decreases radiation dosage to the patient and tends to minimize the lag prevalent in Vidicon and X-icon camera tubes. The pulsed image is then viewed on a large television monitor. In addition, a small 5-inch blue phosphor Kinescope is employed with a Kinescope-recording camera, which is synchronized with the pulsing and the scanning of the X-icon tube and can be operated at either 15 or 30 frames per second. Our TVX system (Fig. 2) is utilized in conjunction with a General Electric Imperial Unit with the viewing monitor suspended from the ceiling and the cinerecording unit in the same room. The equipment is so designed that the X-icon tube can be mounted on the standard fluoroscopic spot-film device or over the x-ray table attached to the side of the spot-film device, thus decreasing the distance between the patient and the X-icon tube. The latter mounting increases the sensitivity and decreases the magnification and distortion produced by the X-icon tube. The clarity of the image on the monitor may be modified by changing the kilovoltage or the milliamperage or by controlling contrast, brightness, and gain. Varying the brightness and contrast alters the presentation of the image. The gain control regulates the amplification of the image and, when increased, the noise level of the system is accentuated. Thus when minimum radiation dosage levels are used the quantum effect is enhanced. The recording unit consists of a 5-inch blue phosphor monitor mounted together with an Auricon G Kinerecording Camera that utilizes a Kern-Paillard Switar *f* 1.5 lens with 25 mm. focal length. On the Kinescope recorder the brightness and contrast levels can be controlled independently of those on the viewing monitor. One additional significant control is electronic magnification of the image on the monitor. This enhances detail and makes filming easier (Fig. 3).

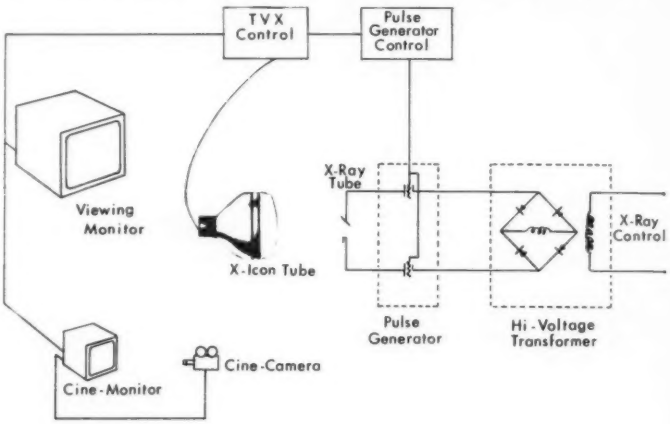

Fig. 1. Schematic diagram of the TVX system.

Radiation Exposure: The kilovoltage necessary to produce an adequate image on the television monitor depends upon the size of the patient and the density of the part to be penetrated as well as upon the distance between pickup tube and patient. In accordance with the inverse-square law, the greater the distance from the pickup tube to the patient and x-ray tube, the greater total radiation dose is necessary to produce a satisfactory image.

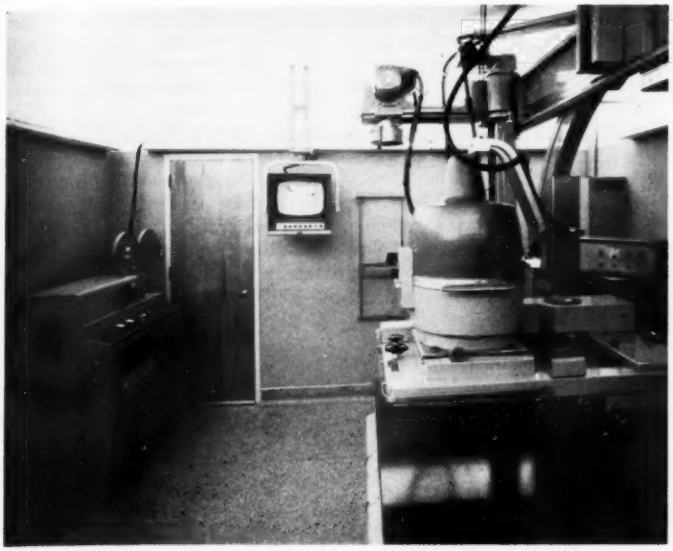

Fig. 2. TVX equipment mounted on a standard spot-film device with viewing monitor and cinerecorder.

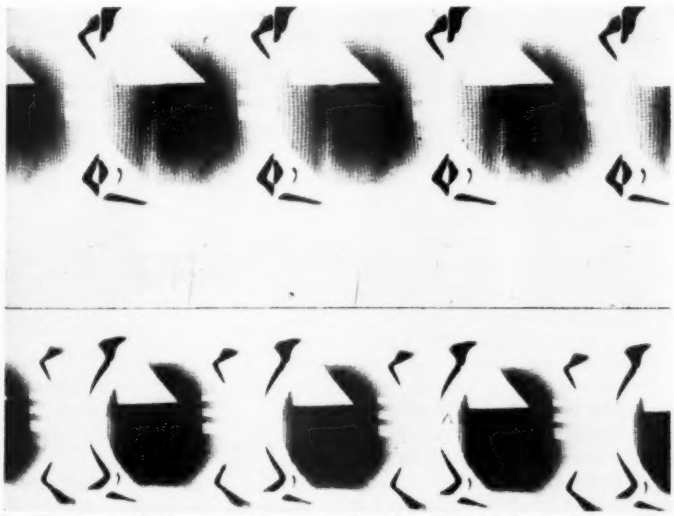

Fig. 3. Phantom and wire screen demonstrating the effects of electronic magnification.

Table I shows representative radiation doses at the table top produced by various kilovoltages and milliamperages. Except in unusual circumstances dosage for fluoroscopic examination and cineradiography does not exceed that of standard fluoroscopy. Roentgen values vary from approximately 0.6 to 9 r per minute at the table top. For example, with a 15-cm. chest, angiocardiography can be adequately performed at 70 to 90 kv with an average milliamperage of 0.5 to 1, at 30 pulses per second and 30 frames per second with a radiation dose of

TABLE I: REPRESENTATIVE RADIATION DOSES AT THE TABLE TOP PRODUCED BY VARIOUS KILOVOLTAGES AND MILLIAMPERAGES

Kvp	Average Ma	Pulses per Second	Table Top r per minute
70	1/2	30	0.6
80	1	30	1.8
100	1	30	3.6
120	1	30	5.5
120	2	30	7.0

0.6 to 3.6 r per minute. Klatte, Campbell and Lurie (3) reported the dosage for a 15-cm. chest during filming on the Westinghouse and Philips intensifiers as 13 and 4.1 r per minute respectively. For a 20-cm. chest the TVX dose would be from 3.6 to 4.9 r per minute, whereas with the electronic type of amplifier anywhere from 13 to 26 r per minute is administered to the patient.

Filming and Processing: We have encountered considerable difficulty in establishing filming technics. Campbell *et al.* (4) have discussed many of these problems previously. Once the proper kilovoltage has been selected for adequate penetration, then milliamperage, contrast, and brightness must be adjusted to get adequate contrast as well as sufficient illumination for recording on film. The *f* stop of the lens is not only dependent upon the brightness of the image but on the type of film and processing employed for the presentation. There are obvious advantages in handling and processing 16 mm. film. The light intensity allows use of a fine grain film. Delineation of the raster lines assures recording the information available from this system. DuPont's 834 Television Recording Film processed with Kodak's Dektol developer appears most satisfactory.

Advantages and Disadvantages: During the first several months following the installation of the TVX unit a 12-inch X-icon tube was available. This tube produced excellent detail and was quite sensitive to radiation; however, it deteriorated rather rapidly and temporarily an 8-inch tube has been substituted. This gives a considerably smaller field with an effective diameter of only 6.5 inches. Present continuous utilization of such tubes is not yet feasible so that the system must be employed for selected cases.

The TVX system is capable of utilizing a large field without the bulk required for a similar size in other types of image intensifiers. The unit as shown houses the large 12-inch pickup tube and is no larger or bulkier than many of the 5- to 8-inch amplifiers. Since filming can be performed at radiation dosage levels no greater than those needed for fluoroscopy, obtaining longer sequences as well as refilming questionable or inadequate studies without excessively exposing the patient is possible. This should lead to more complete physiological as well as motion studies in various systems and structures of the body. The ability to view the examination remotely with as many monitors as one desires can be of tremendous value in teaching. A certain amount of lag appears to be inherent in this as in other Vidicon systems, but with a well functioning tube it is rapidly erased by pulsed radiation and a sharp motion study can be obtained. Once a tube has begun to deteriorate, however, images appear to burn themselves onto the target so that effective motion is lost. While the ability to control gain, contrast, and brightness are of considerable value in viewing the fluoroscopic image, the many possible variables complicate filming technics. Filming of the television image on the Kinescope recorder is probably more difficult than with other systems, due to the marked sensitivity of the tube on the recording monitor to changes in penetration, gain, etc. There is also difficulty in measuring and noting the peak video signal or light intensity.

Clinical Applications: The clinical and research applications of the TVX system are of course similar to those of other forms of cineradiography (5-7). The large field size, however, may enhance the usefulness of this modality in angiocardiography, and the low radiation levels may make feasible motility studies of large segments of the gastrointestinal tract. The combination of the large field size and the low radiation dosage levels may also permit extensive functional studies of the urinary tract, beginning from the time of the injection of the contrast medium. We have been impressed with the result of filming myelograms, and in several instances have been able to record defects occurring during motion of the column of contrast material that were lost in standard filming technics when the area was filled with medium. To date, most of our efforts have been directed toward establishing good reproducible filming technics. Once this is accomplished multiple clinical applications will be made.

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[1] From the Department of Radiology, General Rose Memorial Hospital, Denver, Colo. This project is supported by a grant from the John A. Hartford Foundation. Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

Cinecholedochography[1]

STEVENS S. SANDERSON, M.D., and KENNETH E. GROSS, M.D.

Roentgen examination of the biliary excretory system was begun by injection *via* fistulae through tubes placed within the common duct or by direct puncture of the gallbladder at least forty years ago (1). Operative cholangiography was performed with a demonstration of intrahepatic stones by 1932 (2). Examination in the operating room or on the postoperative patient is a well documented procedure and its benefits and values are well known.

The cinecholedochographic study outlined here is not considered a replacement for operative cholangiography or for the conventional postoperative examination but is intended as a supplement to these. It is believed that this modality affords a superior method of evaluating the physiopathology of the ductal system (3), a procedure which was considered of major importance as early as 1938 (4). The conventional film examination is carried out simultaneously with the cineradiography and in this manner the benefits of both methods are available.

Equipment: An 8-inch amplifier with a synchronized 16-mm. motion-picture camera is used. The exposures are controlled by photocell circuitry and thus the amount of radiation delivered to the patient is regulated, as is the proper film density. The irradiation levels appear to be within reasonable limits for an examination carried out in the right upper quadrant. Gonadal protection is used where indicated.

Procedure: The procedure is simple and not time-consuming, demanding no special preparation of the patient except for the assistance of colon cleansing of some nonambulatory patients.

Any of the modern water-soluble intravenous opaque media in 20 to 40 per cent iodine concentration are suitable. The agent is injected through the plastic tube or T-tube in the common or cystic duct after irrigation of the system with saline. Care is taken to prevent the introduction of air by injection from the syringe or evacuation of gas from the duodenum into the biliary tree.

Filming is done at 7.5 frames per second under fluoroscopic control. Any projection desired is obtained merely by rotating the patient, while erect or supine. This allows excellent visualization of the entire hepatic tree so that superimposed hepatic ducts are not obscured. Spot-films of critical areas or suspicious regions are interspersed between

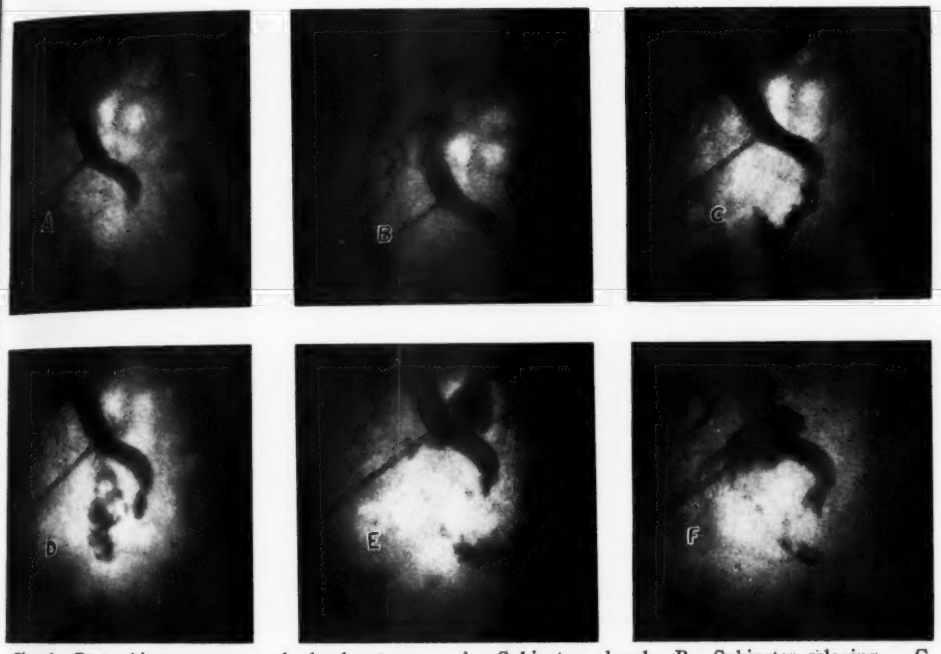

Fig. 1. Post-sphincterotomy and duodenotomy. A. Sphincter closed. B. Sphincter relaxing. C. Sphincter open. D. Sphincter closing (postoperative muscle defect contains medium). E. Sphincter contracting further (postoperative mucosal out-pouching retaining medium). F. Severe contraction of sphincter (appearance of calculus at sphincter level with dilated common duct).

the cineradiographs where greater detail is desired. This is particularly helpful for visualization of intrahepatic calculi.

Experience: The limited number of studies accomplished to date have afforded the following information:

A base line of normal anatomy and physiological behavior has been established and the normal caliber of the ductal system has been recorded. It appears that normal ductal emptying begins immediately as the medium reaches the sphincter of Oddi. This is usually abruptly interrupted by sphincter contraction as the common duct distends to a slightly greater degree. In approximately 50 per cent of the cases studied, there has been some pancreatic reflux. Sphincter contraction appears to be intermittent and the flow of contrast material from the common duct is at no time interrupted for long periods.

Evaluation of the post-sphincterotomy appearance of the ampulla of Vater and the sphincter of Oddi has been made possible by this modality. It is apparent that sphincterotomy does not completely destroy sphincter function. Figure 1, taken from a cineradiographic examination performed on a 63-year-old man, demonstrates the usual appearance after sphincterotomy. This patient had a previous cholecystectomy with a calculus remaining in the common duct. The present surgical procedure was for removal of the residual stone, and sphincterotomy and duodenotomy were simultaneously performed. Obviously, the cineradiographic study affords many multiple views and various projections not reproducible here. Demonstrated on this selection of six frames is a small outpouching visible in the region of the sphincterotomy, believed to be a mucosal hernia through the defect in the muscle wall. It is also quite apparent that sphincter function persists. Solitary views of this particular sphincter region when contracted might lead to a mistaken conclusion that a nonopaque calculus was present here (Fig. 1, F). This apparent filling defect was seen on many views on multiple examinations of post-sphincterotomy patients with dilated ducts.

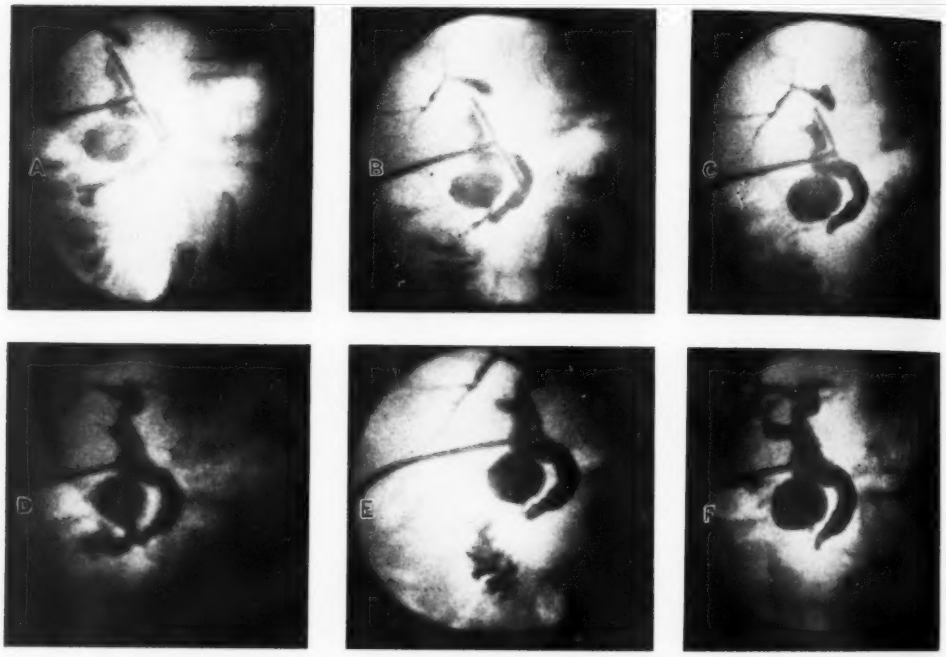

FIG. 2. Sphincterotomy: Large duodenal diverticulum with common duct emptying into it. A. Sphincter open with filling into diverticulum. B. Sphincter relaxed. C. Sphincter closed below diverticulum. D. Sphincter completely relaxed. True caliber of duct seen. E. Sphincter again contracted. F. Sphincter beginning to open again.

In several cases in which the conventional examination did not make the exact anatomical arrangement or physiology evident, assistance was afforded by the cineradiographic study. An example of this is the case illustrated in Figure 2. On the cineradiographic study, it is obvious that the common duct enters a duodenal diverticulum as well as persuing the usual course to the duodenum. The order of filling of the structures and their emptying is clarified and better evaluated by cineradiography.

SUMMARY

Cinecholedochography is a valuable addition to our diagnostic armamentarium and should be used to augment the conventional postoperative examination of the biliary ductal system in patients in whom it has been considered necessary to insert a T-tube or other drainage tube within the common duct. It serves to demonstrate and better to evaluate the postoperative defect caused by sphincterotomy and emphasizes the persistent function of the sphincter mechanism following such surgery. It assists in correct diagnosis of the presence or absence of calculi in the ductal system which has dilated preceding the surgical procedure, whereas conventional solitary film examination has led to a mistaken conclusion regarding calculi remaining in the common duct. This method allows evaluation of the pancreatic duct and its physiological behavior when filled, as well as almost limitless visualization of the entire hepatic tree.

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Evaluation of Performance of Image Orthicon, Vidicon and Permachon Television Camera Tubes in Conjunction with Fluoroscopic Image Intensifiers[1]

HERBERT M. STAUFFER, M.D., and GEORGE C. HENNY, M.D.

Television systems are now widely used in conjunction with image intensifiers to display fluoroscopic information. The relative merits of Orthicon vs. Vidicon systems in fluoroscopic practice have not been clearly defined. An opportunity to compare the two in a laboratory was provided by a research project involving image Orthicons with a 9-inch image intensifier for stereoscopic fluoroscopy. A storage Vidicon (Westinghouse "Permachon"), which will retain a still picture for several minutes, was also evaluated in conjunction with an image intensifier. In a preliminary study, immediate display of planigraphy was made possible by mounting the intensifier with TV camera at the film level in the cassette-transport mechanism.

An image Orthicon (R.C.A. 6489) and a Vidicon (Westinghouse 7325) tube have been compared at 85 kvp (2 mm. Al filter) with use of the Burger (1) test plate with several thicknesses of phantom. With 1.2 mr per minute at the face of the image intensifier (equivalent to a 25 cm. abdomen with conventional fluoroscopy) the image Orthicon picks up detail-contrast (5 mm. diameter hole 5 mm. deep) equal to conventional fluoroscopy at 360 mr per minute while the Vidicon is unable to show any detail. At 14 mr per minute (equivalent to about a 15 cm. thick part) the detail-contrast (3 mm. hole 3 mm. deep) is the same on the image Orthicon as it is on the Vidicon. At 95 mr per minute on the image intensifier the image Orthicon is "flooded" with light and the Vidicon gives better results. At this intensity the limit of visibility for the Vidicon is a 2 mm. diameter hole 2 mm. deep. In regard to motion of an object in the x-ray beam it is found that there is much more after-image or "trailing" with the Vidicon than with the image Orthicon, especially at low x-ray intensities. This is well demonstrated when a rotating lead disk with a rectangular hole is placed in the x-ray beam just in front of the image intensifier.

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Do Estrogenic and Androgenic Hormones Affect the Radiation Reaction of Tumors?[1]

HENRY P. PLENK, M.D., M.S., FRED M. SORENSON, D.D.S.,[2] and ROGER B. FUSON, Ph.D.[3]

In previous publications (4, 5) we have demonstrated that ACTH and cortisone will enhance the inhibitory effect of radiation on tumors in mice. Various authors have suggested that androgens and estrogens may have similar effects. Nathanson (3) observed that with administration of estrogens more intense radiation reactions were obtained in human breast tumor, as well as in the surrounding skin, than with a comparable radiation dose without the hormone. Graham and Graham (2) reported that both testosterone and stilbestrol increased the sensitivity of carcinoma of the cervix to radiation as determined by the response of cells in vaginal smears. Both androgens and estrogens affect the resistance to total-body irradiation. Testosterone increased the mortality in the female, stilbestrol in the male, while estradiol decreased the mortality of male mice (1). Rugh and Wolff (6) observed an increase in resistance to a lethal dose of radiation in castrate male mice given estradiol benzoate. Spellman, Carlson, and Lillehei (7) found that testosterone propionate enhanced the mortality, while long-acting testosterone cyclopentylpropionate decreased the mortality of male mice following total-body exposure. Advanced salivary-gland tumors in man were favorably affected by estrogen therapy alone or in combination with x-ray therapy in small amounts (8).

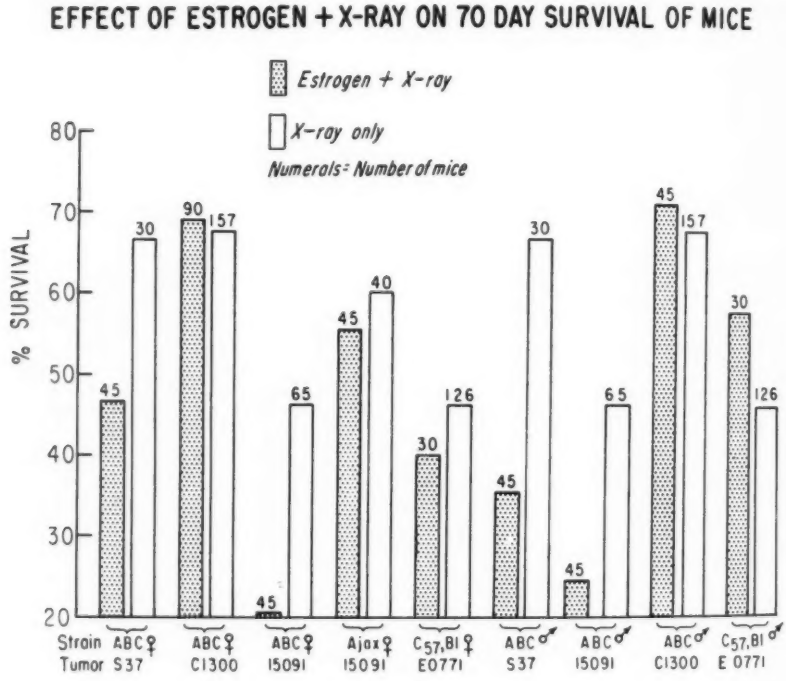

Chart I.

MATERIAL AND METHODS

The following tumors were implanted in the anterior chamber of the mouse:

S37 sarcoma in ABC strain
C1300 neuroblastoma in ABC strain
15091 breast adenocarcinoma in A strain
E0771 breast adenocarcinoma in C57Bl strain

On the fourth day after transplantation 3,000 r/air was administered through a field of 0.8 cm., surrounding the tumor-bearing eye. Survival at seventy days of animals receiving hormone and x-

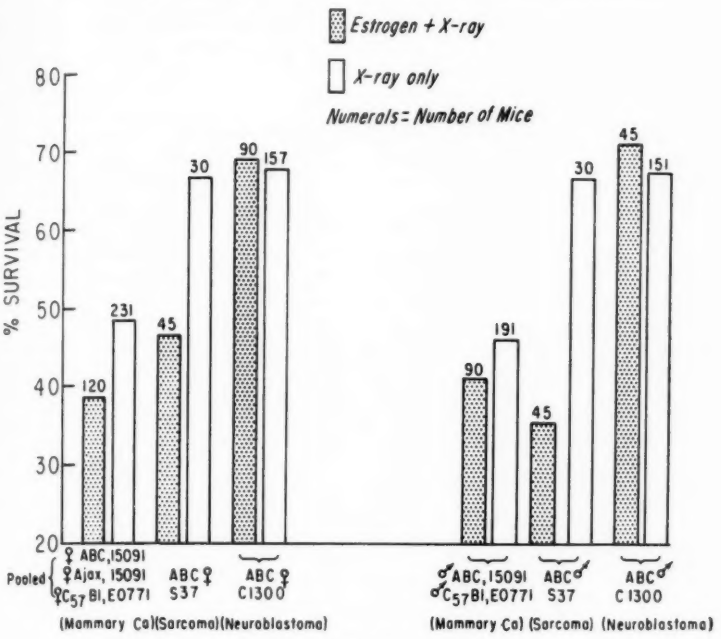

Chart II.

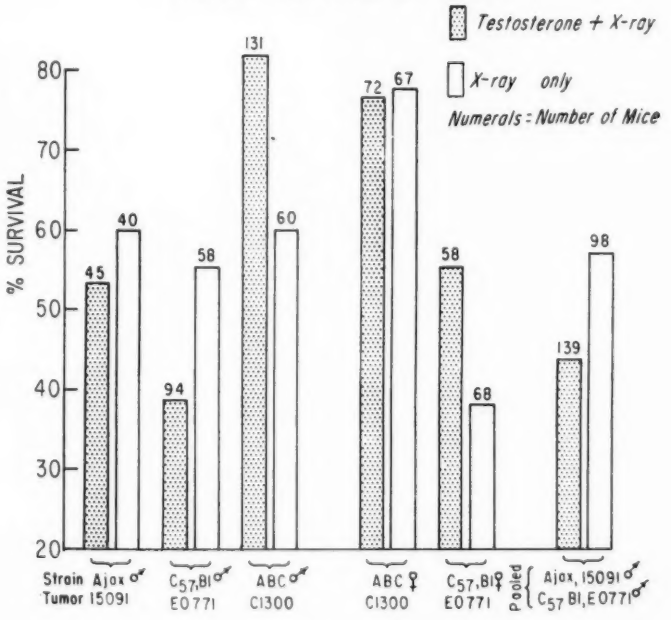

Chart III.

ray irradiation was compared with the survival of animals treated by x-rays alone.

Estrogen in the form of estradiol 17-beta cyclopentylpropionate (Depo-Estradiol) was administered, starting two weeks prior to or on the day of tumor transplant and continued for seventy days in the following doses: 50 micrograms per week, 25 micrograms per week, 25 micrograms every two weeks. The solvent, cottonseed oil, did not produce any noteworthy effect on tumor growth and survival of the animals. Since no significant difference was observed between various dose levels of estradiol, the groups receiving various amounts were pooled.

Testosterone was administered in similar manner, as the long lasting cyclopentylpropionate (Depo-Testosterone) in doses of 10 mg. per week, 5 mg. per week, or 5 mg. every two weeks.

RESULTS

Administration of estrogens produced a significant decrease in survivals (Chart I), apparently reducing the inhibiting effect of x-ray on tumor growth in male and female ABC mice with 15091 breast tumor as well as in male ABC mice with S37 sarcoma. A definite but less striking decrease in survival was found in ABC females with S37 sarcoma and in C57Bl females with E0771 breast tumor. No estrogen effect could be detected in mice bearing C100 neuroblastoma. Chart II reveals that the decrease in survivals of pooled groups of animals with both breast tumors was greater in female than in male mice.

In irradiated animals with breast tumors receiving testosterone and in female mice with C1300 tumor, no significant or consistent change in survival figures could be observed (Chart III). A significant rise in the survival figures was present only in testosterone-treated male animals bearing C1300 tumors.

SUMMARY AND CONCLUSIONS

1. Estrogenic hormone tends to accelerate growth of two breast tumors and one sarcoma but has no influence on C1300 neuroblastoma. The overall seventy-day survival percentage was reduced in animals receiving x-ray irradiation plus estrogen compared with x-irradiated controls.

2. Testosterone produced no significant increase or decrease in survivals of animals with breast tumors. A significant improvement in the survival figure was noted in male ABC animals carrying C1300 tumor.

3. We cannot draw any conclusions regarding the effect of sex hormones and radiation on human tumors from this study, but we find no reason to expect any particularly beneficial effect from the simultaneous use of radiation and sex hormones. The possibility that estrogen may inhibit radiation response has not been ruled out.

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In Vitro Effects of Irradiation Combined with Actinomycin D[1]

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Investigators in recent years have cited the combined effects of drug therapy and irradiation (1). D'Angio *et al.* have reported on the potentiation of x-ray effects by actinomycin D in mice and patients. They mention, however, that clinically it is difficult to assess the synergistic action because of varying responses of individuals and histologically similar tumors (2). Cobb studied the effect of actinomycin D on tissue cultures without irradiation (3).

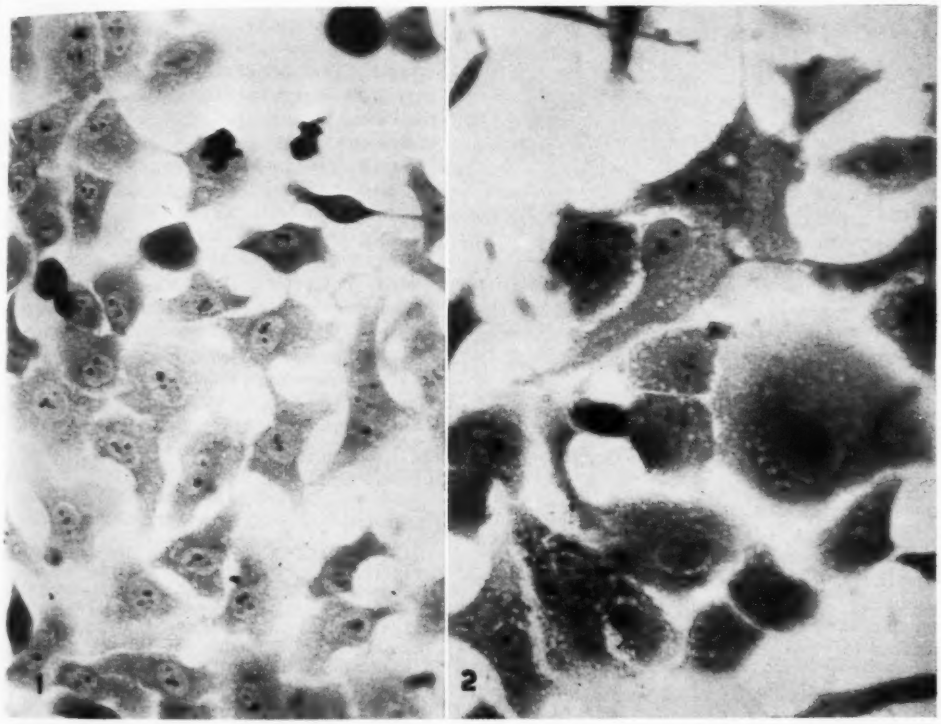

Fig. 1. HeLa cell culture three days after exposure to electron beam or 240 kv (200 r).
Fig. 2. HeLa cell culture three days after actinomycin D, 0.001 μg. per ml.

The purpose of this communication is to confirm the additive effects of actinomycin D and x-rays *in vitro* and furthermore to propose a method for the study of such *in vitro* effects as a means of primary screening.

METHOD

The first part of the experiment consisted of an investigation of the growth of HeLa cells on coverglasses and the effect of the drug and radiation upon them. Six coverglasses, 10 × 50 mm., were mounted with plasma clot on one of the flat surfaces of an 8-ounce Neutraglas screw-cap bottle. Fifteen milliliters of LAH medium with 10 per cent Bovine serum containing one million HeLa cells were introduced into each bottle. Twenty-four hours later, a monolayer growth of HeLa cells was observed on the coverglasses. Actinomycin D was added in a concentration of 0.001 μg. per ml. The qualities of radiation used were 2.2 mm. Cu h.v.l. with the 240-kv machine and the electron beam of the betatron at a 21-Mev energy level. On the basis of the treatment received, the material was divided into groups: (*a*) controls; (*b*) irradiated with the 200-r electron beam at 21 Mev; (*c*) irradiated with 200 r with the 240-kv machine; (*d*) treated with actinomycin D; (*e*) treated with actinomycin D plus 200 r with the electron beam; (*f*) treated with actinomycin D plus 200 r with the 240-kv machine. After being exposed once to the radiations, the coverglasses were observed daily for seven days. Every day one of the coverglasses was removed, fixed, and stained with H and E stains. Significant qualitative and quantitative changes were recorded (Figs. 1–3).

The second part of the experiment was concerned

Fig. 3. HeLa cell culture three days after exposure to combined irradiation and actinomycin D.

with protein determinations, proposed by Oyama and Eagle (4) and Smith *et al.* (5) as an index of quantitative cellular growth. A suspension of HeLa cells containing 50,000 cells per milliliter was prepared in the usual fashion and was placed in plastic containers, 6 × 3 × 2 cm., made by Falcon Plastic Company. The total culture medium and cell volume was 5 c.c. per container. The groups were similar to those listed above, but no coverslips were used. After exposure to each quality of radiation, the protein content of each container was determined at twenty-four and seventy-two hours.

RESULTS

Evidence for the potentiating effect of actinomycin D on x-rays was seen in both parts of the experiment. In a concentration of 0.001 μg. per ml. the drug had some effect on individual cells, which was maximum on the third day; by the seventh day good regeneration continued (Fig. 2). When 200 r were delivered either by the electron beam or the 240-kv unit, there were insignificant changes grossly (Fig. 1). However, when the same dose of the drug and radiation were combined, there was a marked inhibitory response by the third day (Fig. 3), and by the seventh day only a few regenerated clones of cells were found.

The preliminary results of the protein determinations are interesting. The greatest amount of inhibition of protein synthesis was noted twenty-four hours after irradiation, with moderate recovery manifest at seventy-two hours. When compared with the controls, groups treated by the drug or radiations alone gave values 74 to 89 per cent of normal. The combination of drug and radiations gave 50 to 58 per cent of normal protein values, thus producing the greatest inhibition of protein synthesis.

It is possible by higher doses of drug or radiation alone to produce lethal effects, but a better therapeutic ratio between normal and tumor tissues may possibly be achieved through combined therapy. We believe that this method of study of cellular growth and protein determinations offers a good model for investigating or comparing various combined irradiations and drugs, as to their effect on cancer growth before clinical trials.

ACKNOWLEDGMENT: The protein determination was done by John Megley of Abbott Laboratories, North Chicago, Ill.

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Synchronous Field Shaping and Protection in 2-Million-Volt Rotational Therapy[1]

JOHN G. TRUMP, Sc.D., KENNETH A. WRIGHT, M.S., MAGNUS I. SMEDAL, M.D., and FERDINAND A. SALZMAN, M.D.

This presentation is concerned primarily with certain irradiation technics evolved over the past eleven years of clinical radiotherapeutic experience with the 2-million-volt Van de Graaff electrostatic x-ray generator.

Field shaping may be considered to have two objectives: that of conforming the shape of the beam of radiation to the known tumor volume and its possible extension and that of protecting adjacent normal areas by exclusion from the beam. In the absence of motion between patient and beam, the field may be given any desired shape depending upon the clinical problem and the philosophy of the radiotherapist. Accessory protective devices in such stationary-field therapy are usually modifications in the outline or dose distribution of the original field.

Applied to 360° rotation of the patient, a fixed field is usually considered as necessarily symmetrical about the axis of rotation. The use of an accessory protective device in this situation requires in general that it also be shaped and rotate. This more intricate situation is illustrated by the set-up used in the rotational treatment of carcinoma of the thyroid. Here a basic rectangular field is shaped by appropriate absorbers so that the treatment beam includes the entire thyroid bed and lymphatics from the angle of the jaw down to the anterior mediastinum at the level of the carina. The field is shaped to reduce the dose to uninvolved regions such as teeth, cerebellum, and lungs. This shaping, however, does not protect the spinal cord. The accessory spinal cord protector, a lead rod 5/8 inch in diameter, is shaped to conform to the cervical spinal curvature.

In the film[2] the spinal cord protector is shown in the beam and rotating synchronously with the patient so that its x-ray shadow falls exactly on the cord for all angular positions. Mechanically this is accomplished with the aid of a small selsyn motor mounted on the face-plate of the x-ray generator. The motor is synchronized with the rotating treatment chair. The patient and cord protector require approximately three to four revolutions for a daily tumor dose of 175 r; the spinal cord dose is reduced to approximately 50 per cent of the tumor dose. Black and white film is used to show the shadow cast by the continuously rotating cord protector within the fixed, shaped thyroid field.

The second part of the movie illustrates the concept of variable field shaping during rotation. The example is from a case of carcinoma of the urachus with extension to the urinary bladder. The cancer, lying on the parietal peritoneal surface of the anterior abdominal wall, extended as a narrow band from the umbilicus to the bladder dome. Here it spreads to infiltrate the anterior and superior surfaces of the bladder. The usual multiportal or rotational technics applied to give a tumor dose of 6,000 r would result in an undesirably and unnecessarily high dosage to the small intestine. The tumor volume to be treated was of an essentially rectangular shape in the anteroposterior projection, whereas in the lateral view it was L-shaped, with a narrow vertical strip extending from the umbilicus down to the bladder dome, where it necessarily widened posteriorly to include the entire bladder. To limit the beam of radiation to this changing shape continuously during the rotation of the patient, two stacks of oval brass absorbers were used, each rotating synchronously with the patient, and each defining one continuously changing edge of the field. The brass absorbers are oval and so stacked on the rotating spindle as to change the respective edges of the field from a vertical rectangle in the anteroposterior view to an L-shape in the lateral view.

The movie shows the steps necessary in setting-up this sculptured field with the patient in the standing treatment position. Black and white film depicts the portal radiographs taken during the set-up and the changing shape of the field as it casts its shadow on a white card.

Field shaping and protection in a restricted sense are inherent concepts in the planning of treatment by any radiation modality. In rotational therapy they may acquire special values and reveal new approaches to the problem of administering the radiation where desired and restricting it where not desired. Such synchronously variable fields provide the means to treat the tumor adequately and yet provide protection to selected adjacent and interior tissue regions.

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[1] From the High-Voltage Research Laboratory, Department of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. (J. G. T. and K. A. W.) and the Department of Radiology, Lahey Clinic, Boston, Mass. (M. I. S. and F. A. S.). Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

[2] A 16-mm. magnetic sound track movie, in color and black and white (running time twelve minutes), was shown with this presentation.

Time-Dose Relationship in Hodgkin's Disease[1]

RALPH M. SCOTT, M.D.[2]

Hodgkin's disease presents the radiotherapist with a variety of clinical pictures ranging from early, apparently localized involvement to disseminated disease which is nearly terminal. The pathologist distinguishes between Hodgkin's paragranuloma, granuloma, and sarcoma. More than one type may be found in the same person, and transition from one to another is not uncommon. Although the peak incidence is in the third decade, the condition may be and frequently is encountered in the young and the old. Associated disease is not unusual. These factors, plus others, make each case an individual problem in management.

In some instances a protracted course of therapy with a relatively high total dose seems desirable, while at the other end of the scale a single exposure or, at most, a short course will handle the situation adequately. From this it follows that a guide as to the optimal dose in any overall period of time would be desirable.

Time-dose graphs are available for a number of conditions, but a perusal of the literature shows only one such piece of work relating to Hodgkin's disease. Friedman and Pearlman (1), in a paper on mycosis fungoides, published a curve but did not include the data upon which it was based. Du Sault (2) has recently transposed this curve from a linear graph to a straight line on a log-log paper. Such a presentation has come into widespread use since Strandqvist published his classical work on skin cancer in 1944 (3).

This study was undertaken in an attempt to construct a graph from the clinical material available in the University of Chicago Radiation Therapy records. Three hundred and four case histories dating back to 1930 were studied and all lesions fulfilling the following criteria were selected to establish the points on the graph:

(A) The diagnosis was definitely established by biopsy. Whether the disease process was considered paragranuloma, granuloma, or sarcoma was not taken into account, since often no such distinction was made in the pathological report and in other instances multiple biopsies revealed transitions from one grade to another in the same patient.

(B) The patient had received no treatment to the areas under consideration prior to being treated in our clinic. This included chemotherapy and hormonal therapy as well as radiation therapy.

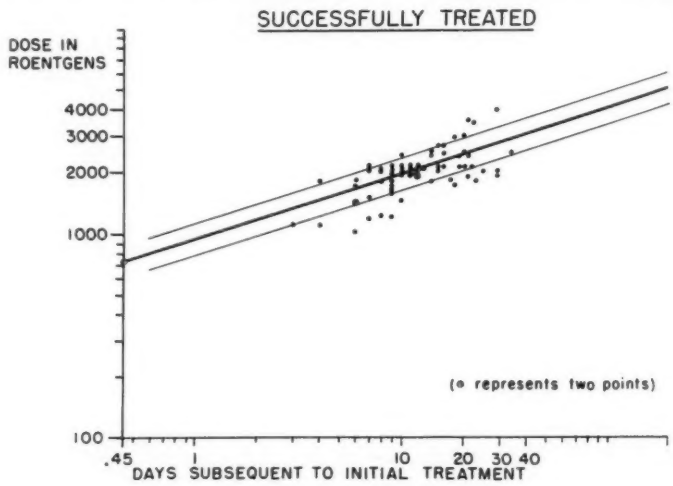

Figure 1

(C) The patient did not receive chemotherapy or hormonal therapy during the period of follow-up. This excluded a large number of lesions which otherwise might have been considered successfully treated.

(D) The treated lesion showed no clinical evidence of recurrence over a four-year period of follow-up or was not recurrent at postmortem examination. Four years seemed adequate, since our average survival was slightly under three years.

Seventy-five lesions meeting these criteria were found. These were then plotted on log-log paper with time in days subsequent to the initial treatment on the x-axis and dose in roentgens on the y-axis. The dose expressed represents the minimal tumor dose as estimated by the prescribing physi-

cian. Over the time involved this consists of the work of several radiotherapists and many different residents. According to the method of least squares, the position and slope of a line best connecting these points was then constructed (Fig. 1). Since for very short periods dose is independent of time, two single exposure treatments were not utilized in making the curve. Any time-independent zone must be represented by a horizontal line. In this study the two single dose treatments would fall at 0.45 days. This is the point at which recovery becomes apparent and additional dose must be given as time is increased for equal effect. For skin cancer Strandqvist found that this applied down to 0.35 days. and other matters which determine general condition.

As a test of the usefulness of the line, all recurrences in the series which met the first three of the above criteria were plotted (Fig. 2). One hundred and nine such lesions were encountered. Of these, only 9 fell on or above the line. None fell above the upper limits of a single standard deviation of the line. While the line obviously does not represent a true expression of the time-dose relationship in Hodgkin's disease, it would seem useful as a guide as to the dose in time which must be given for a reasonable expectation of successful therapy. It is presented merely as such.

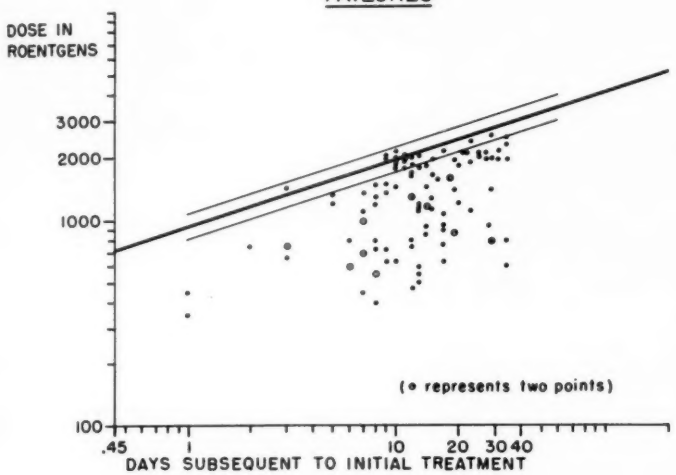

Figure 2

Errors which are inherent in the construction of such a line are readily apparent. Mathematical analysis of biological data is unavoidably subject to variation. Differences in tumor-host relationships must make this a fact. While this may not be too significant in a group made up of many cases, seventy-five is not a large series. One or two points at either end of the line, above or below it, could significantly change its slope. Friedman's data as presented by Du Sault show a significantly steeper slope than that found here. Further study certainly seems desirable.

Recurrences limit the line inferiorly, and these are readily evident, but the question of whether higher doses which would change the position of the line would not be more desirable is less easily answered. The factors which tend to keep the dose down in treating this disease are less tangible than skin necrosis would be, for example, and are less likely to find their way into the patient's chart. These would include the things which make up systemic tolerance —the blood picture, troublesome mucositis, radiation sickness, the nutritional status of the patient,

ACKNOWLEDGMENT: The advice and assistance of Dr. L. H. Lanzl of The Argonne Cancer Research Hospital and University of Chicago in the mathematical and statistical analysis of these data are gratefully acknowledged.

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Tissue Isodose Curves for Beta Surface Applicators[1]

WESLEY G. McTAGGART, B. S., WALTON D. WEST, M.S.,
HARRY A. CLAYPOOL, M.D., and VINCENT P. COLLINS, M.D.

Beta-emitting surface applicators have been in clinical use for many years. The inconsistencies between physical dosage and clinical results have been such, however, that it has, for practical purposes, fallen upon each clinician to evaluate his own applicator on the basis of his personal experience. Poor correlation has resulted when attempts were

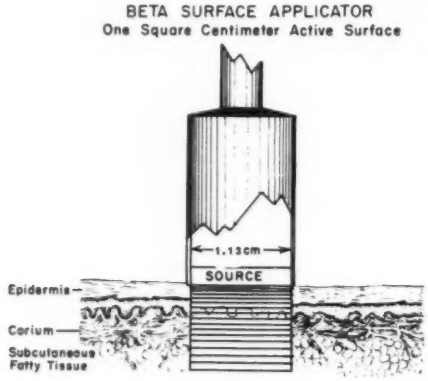

Figure 1

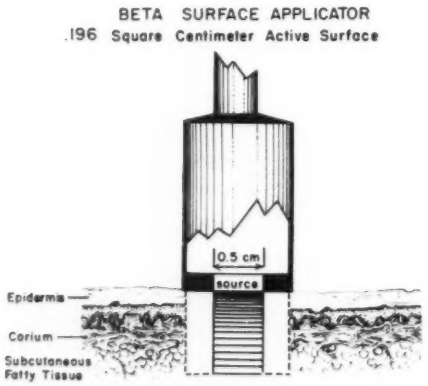

Figure 2

made to compare results from one applicator with those from another, or from one clinic with those from another. Hughes (1), impressed by these difficulties, asked the question, "How can an ophthalmologist or radiologist be certain of the clinical effect to be expected from a specific applicator?"

The strontium-yttrium-90 applicators are in common usage today in many clinics and offices. The half-life of strontium 90 is given as twenty years (2). In some cases of recalibration of these applicators, the dose rate was found to have decreased by as much as 70 per cent of one half-life in one year. This rapid change in the strength of an applicator with a long half-life can be explained only by inconsistencies in the methods of calibration. Yet the same methods of calibration are in use today.

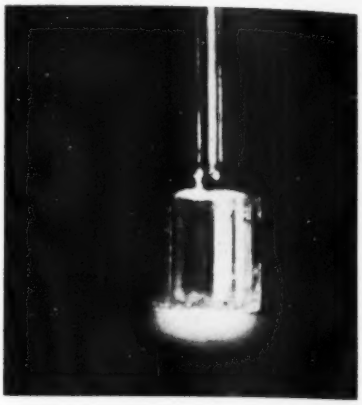

Fig. 3. Fluorescence in tissue equivalent plastic phosphor crystal.

In clinical medicine we must accept occasional inconsistencies in therapeutic results because of normal biological variation. However, we have felt, as have others, that the lack of consistency of results in the case of topical beta therapy has been significantly beyond the limits of normal variation.

It is evident that a fundamental error exists, either in the hypothesis, in the technic, or in the interpretation of the experimental data used in support of the hypothesis. In an effort to clarify the basic concepts of the dose delivered to tissue by a surface beta applicator, we must first understand the steep gradient of absorption of particulate radiation. Any surface beta applicator has a finite area, usually 1 sq. cm. or less, with a uniform distribution of radioactive material over its surface.

Assume that such a beta applicator, emitting 100,000 beta particles each second, is placed in contact with an area of tissue. Since these particles may possess energies ranging from a few hundred electron volts up to a maximum value of several million electron volts, it is evident that they will penetrate to significantly different depths in the tissue. If we assume that 100 per cent strike the surface, 40 per cent penetrate to a depth of 1 mm., 16 per cent to a depth of 2 mm., etc., the resulting density of the radiation within the tissue would be as shown in Table I.

A practical example is shown in Figure 1. This figure demonstrates a hypothetical distribution of beta radiation density within a 1.0 c.c. block of tis-

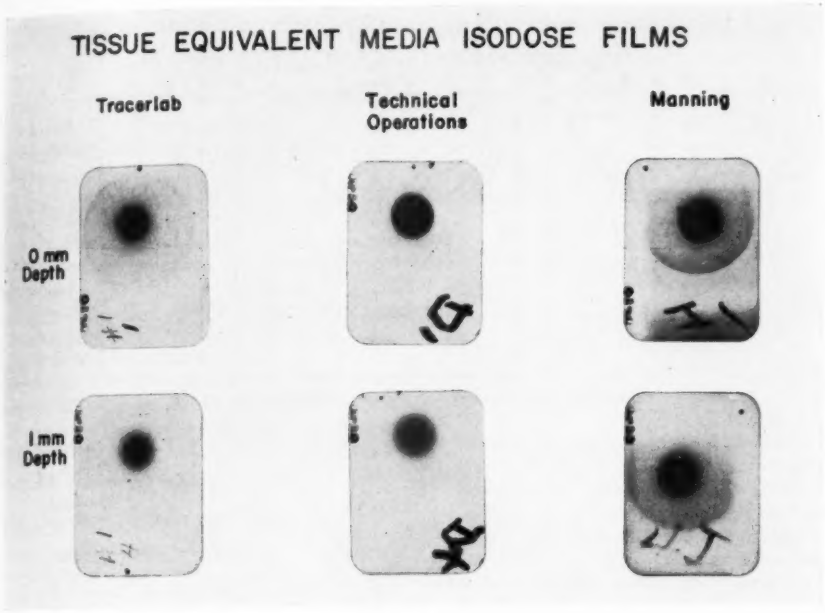

Figure 4

TABLE I: HYPOTHETICAL BETA ABSORPTION

Depth (cm.)	Particle Density per cm.² per sec.
0	100,000
0.1	40,000
0.2	16,000
0.3	6,400
0.4	2,600
0.5	1,000
0.6	400
0.7	160
0.8	66
0.9	22
1.0	0

sue under the applicator. It is apparent that 100 per cent of the radiation is absorbed within the 1.0 c.c. of tissue. But if we now express the dose delivered as 100,000 beta particles per cubic centimeter, an erroneous impression is created that the radiation is equally distributed throughout the block of tissue.

Now consider the example of the applicator which has an active diameter of 5 mm. (Fig. 2). Many commercially available applicators are of this size and configuration. The active area of this applicator is 0.196 sq. cm. Assume again that 100,000 beta particles emerge from the face plate each second. It is evident that 100 per cent of the radiation is absorbed in something less than 1.0 c.c., namely, in 0.196 c.c. This is considerably less than 1.0 c.c., but it would not be incorrect to state that the 100,000 beta particles are absorbed in the 1.0-c.c. block of tissue immediately beneath and around the applicator. However, an even more erroneous impression of uniform absorption is created.

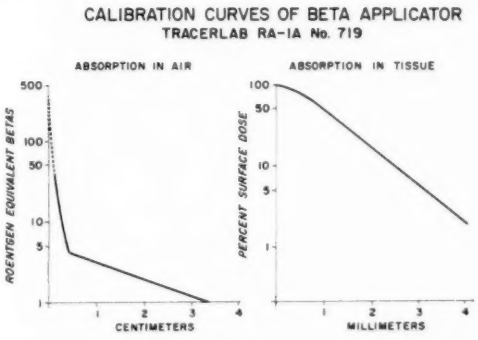

Figure 5

Although both examples fall within the definition of a rep, or roentgen equivalent physical, the erroneous implications cannot be overlooked. The definition is simply not sufficiently explicit to cover the situation in which less than a cubic centimeter of tissue is irradiated. Yet, just such an interpretation is widely used as a method of "calibration" of beta surface applicators.

This is the principal fallacy in the presently used system of dosimetry for beta surface applicators. Other difficulties appear to stem from this inadequate interpretation. The problem first came to our attention following the acquisition of a Tracerlab Model Ra-1A Strontium-90 Beta Medical Applicator. Figure 3 shows this applicator in contact

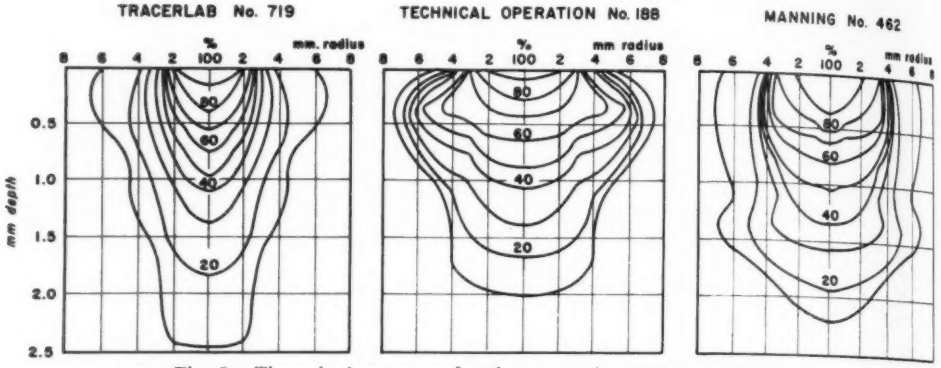

Fig. 6. Tissue isodose curves for three strontium-90 beta applicators.

with the surface of a plastic phosphorescent crystal and demonstrates the rapid attenuation of the radiation within the crystal. With the purpose of evaluating this phenomenon for clinical application, our investigation has the following objectives:

1. Calibration of beta applicators must employ standard methods of radiation detection and measurement.
2. The method must have its foundation on a familiar standard set of conditions.
3. The method must give reproducible results.
4. The precise point by point dosage within tissue under an applicator must be known. Hence, isodose curves are a requirement.

Our approach to the problem involved five steps:

1. Measurement of dose rate *vs.* distance, up to 1.5 cm. from the applicator, with an open end air ionization chamber.
2. Measurement of absorbed beta particles *vs.* distance from the applicator from 1.5 to 0.2 cm. by densitometric evaluation of exposed films.
3. Appropriate calibration of the film against known standards. Grenz rays with equivalent half-value layer were chosen for this purpose.
4. Evaluation of the exposed film, using a small (1.0 mm. diameter) circular aperture, to determine the dose variation with distance from the central axis (Fig. 4). Tissue isodose curves were subsequently prepared from this data.
5. Determination of "surface dose" by extrapolation of experimental data from the 2 mm. measurements (Fig. 5). Extrapolation was actually done on the curve of coefficients of attenuation at the surface.

The "surface dose rate" was taken as that dose on the central axis at the surface of the applicator. For reasons previously stated, the dose was expressed in roentgen-equivalent-beta (r.e.b.). Results of the method permitted the construction of isodose curves in tissue equivalent media which are believed accurate to ±5 per cent.

Isodose distributions from three different applicators were obtained and compared (Table II).

TABLE II: COMPARISON OF THREE STRONTIUM-90 BETA APPLICATORS

	Tracerlab RA-1A (No. 719)	Technical Operations M-1 (No. 188)	Manning B-1 (No. 462)
Active/total diam. (mm.)	5.0/12.7	5.0/10.3	7.0/10.3
Face plate	0.0025 mm. monel metal	...	0.1 mm. stainless steel
Extrapolation chamber	51 rep/sec	58 rep/sec	96 rep/sec
Film dosimetry	372 r.e.b.	424 r.e.b.	317 r.e.b.

It was immediately evident that an applicator designated as "twice as strong" as another by virtue of its calibration by the extrapolation chamber method presented isodose curves which, although demonstrating a larger area of irradiation, did not differ significantly in the dose rate at a specified depth under the applicator (Fig. 6).

The adoption of an adequate calibration procedure for beta surface applicators is needed. Isodose curves for each applicator should be prepared. Any form of radiation can be dangerous unless its characteristics are fully understood. Only through a full knowledge of the characteristics of each beta applicator can we hope to improve the correlation between physical dosage and biological effect in those diseases which are treated with beta surface applicators.

[1] From the Department of Radiology, Baylor University College of Medicine, Houston, Texas. Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

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Considerations of Shielding for Cesium-137 Sources, Containing Cesium 134

R. A. BEIQUE, Ph.D., and M. N. LOUGHEED, M.D.

The present paper is the outcome of studies made in designing, building, and installing a unit containing a 2,000-curie Cs^{137} source, with a maximum additional activity of 5 per cent of Cs^{134}. At 1 meter from the center of this source (2 per cent Cs^{134} content), the reading in the off position outside of the head is 0.2 mr/hr. maximum. Although the room used for housing the unit was originally designed and shielded for a 280-kvp x-ray therapy unit, in an adjacent secretarial office the maximum dose rate during operation is 1 mr/hr. at 90° to the primary beam, incident on a water phantom.

In the design and construction of this unit we drew heavily on all information that was available in the literature. Certain graphs and charts were constructed to assist in the calculation. It is these that form the basis of this paper.

TABLE I: CESIUM 137 AND 134 SPECTRA

	Gamma Energy (Mev)	No. of Gamma Per 100 Disintegration	Output Rhm/Curie	Output % of Total		T1/2 (yr.)	Decay Constant (%)
Cs^{137}	0.66	100	0.324	100		30	2.3 per year
Cs^{134}	1.36	4.6	0.033	3.7	6.6	2.3	2.5 per month
	1.17	3.	0.019	2.1			
	1.04	0.9	0.007	0.8			
	0.8	109.	0.39	44.	44.		
	0.6	100.	0.36	41.	49.4		
	0.57	12.8	0.04	4.5			
	0.56	9.4	0.03	3.4			
	0.47	1.8	0.005	0.5			
			0.88	100			
Co^{60}	1.17	100	0.60	50.		5.2	1 per month
	1.33	100	0.68	50			
		200	1.28	100			

An examination of the spectra of Cs^{134} and Cs^{137} is in order (Table I). In comparison with Co^{60}, which has a half-life of 5.2 years, Cs^{137} has a half-life of thirty years and Cs^{134} two and three-tenth years. The Co^{60} spectrum is 1.17 and 1.33 Mev, the Cs^{137} is 0.66 Mev. In contrast, Cs^{134} has 8 gamma components, which can be divided into three main groups: a high-energy, above 1 Mev; middle energy, about 0.8 Mev; and a low-energy, 0.6 Mev and below. Relative output of the three isotopes per curie is given in the third column of the table.

With this background of information, it is apparent that planning the shielding of a treatment head for loading with Co^{60}, or pure Cs^{137}, is reduced to a problem of calculating the necessary number of half-value layers. With Cs^{134} the problem is more complex. The shielding material for Cs^{137}, consisting of high-atomic-number metals, effectively excludes the low-energy group of Cs^{134} by photo-

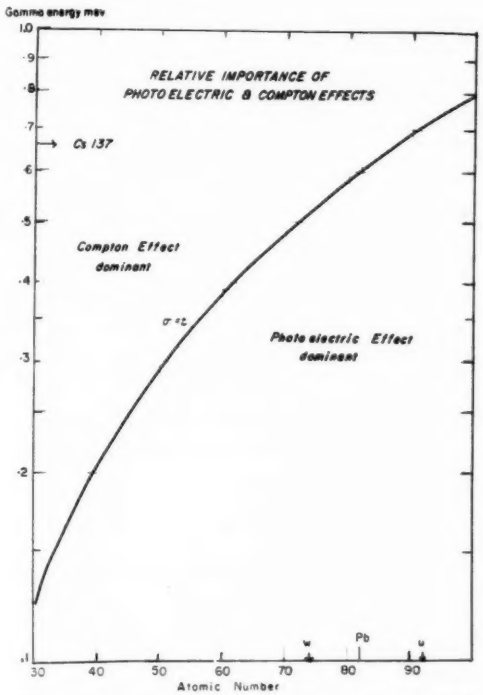

Fig. 1. Curve showing point at which photo-electric effect equals Compton effect with relation to atomic number and energy. (R. D. Evans, in Handbuch der Physik.)

electric absorption. The higher three energies of Cs^{134} rely predominantly on density shielding factors rather than photoelectric, and therefore it is these which present the problem. Since the energies above 1.0 Mev account for only 6.6 per cent of all the Cs^{134} output, it is actually 6.6 per cent of 5 per cent that provides most of the difficulty.

The significance of density is shown on the absorption curve for concrete (Fig. 2), which starts at a maximum with 0 inches of concrete. The rate of absorption of Co^{60} and of Cs^{137} combined with Cs^{134} diverges but little, since the absorption is of the Compton type in all three (Kirn *et al.*).

The situation is markedly different with lead (Fig. 3). The Cs^{134} curve can be broken into three segments. The first linear part is that dominated by the absorption of the lower-energy gamma rays (solid line); the second part (broken line) shows the influence of the intermediate gamma rays (energy approximately 0.8 Mev); and the third part, also linear (solid line), shows the influence of the energetic gamma radiation, above 1 Mev, passing through 15 cm. of lead. This is the 6.6 per cent of the Cs^{134} previously mentioned, and its direction is

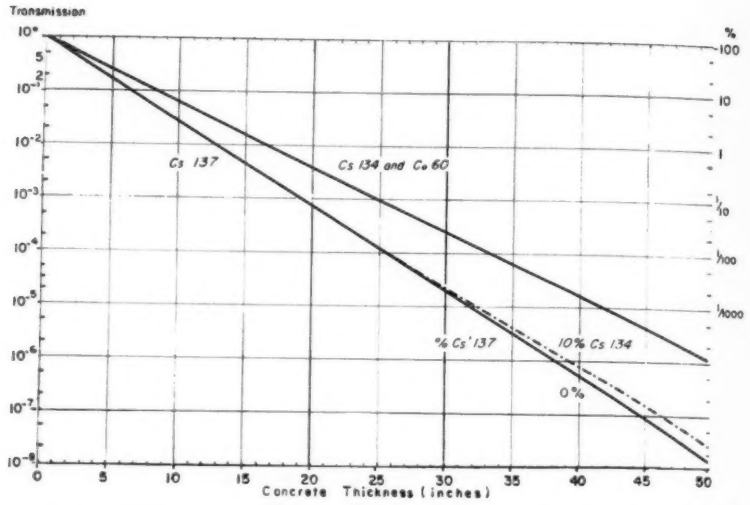

Fig. 2. Transmission of cesium radiation through concrete compared with Co^{60}.

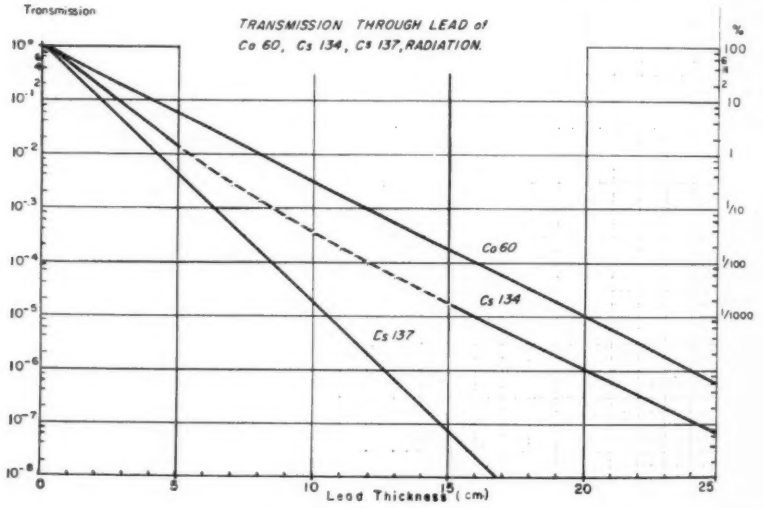

Fig. 3. Comparative transmission through lead of radiation from Cs^{137}, Cs^{134}, and Co^{60}.

parallel to that of Co^{60}. Available cesium sources are usually a mixture of Cs^{137} with a small percentage of Cs^{134}. In Figure 5 the curve farthest to the left shows the transmission through lead of pure Cs^{137}. The other curves are for Cs^{137} with varying content of Cs^{134} (1 to 10 per cent). The significant point is that the 1 per cent curve is separated from the 0 per cent curve significantly beyond layers of lead of 6 to 7 cm. thickness, and so on for increasing percentages of Cs^{134}.

The graph can be adapted to provide practical information for alternate loading (Fig. 5). For example, a unit designed for a certain load of pure Cs^{137} may have to be loaded with one containing some Cs^{134}. To illustrate, a head for a source of pure Cs^{137} of 1,000 rhm output, can only be loaded with a 260-rhm source if there is a 2 per cent content of Cs^{134}.

The decay constant is also a factor creating a problem in evaluating dose rate (Fig. 6). For Cs^{137} it is 2.3 per cent per year and for Cs^{134} 2.5 per cent per month. Actually, the decay rate of Cs^{134} is 2.3 per cent per month, but in terms of total activity of the source it is 2.5 per cent, superimposed on the Cs^{137} decay rate of 2.3 per cent per year.

As has been noted (Table I), the output per curie of Cs^{134} is larger than that of Cs^{137}. The graph in Figure 7 shows the increase in output

effected by the addition of a certain percentage of Cs^{134}; 1 per cent Cs^{134} for example, increases the

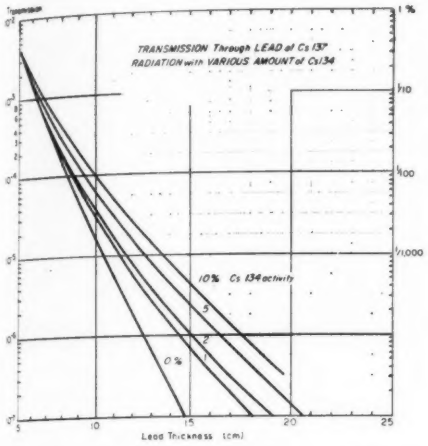

Fig. 4. Effect of the addition of Cs^{134} to Cs^{137} in transmission through lead.

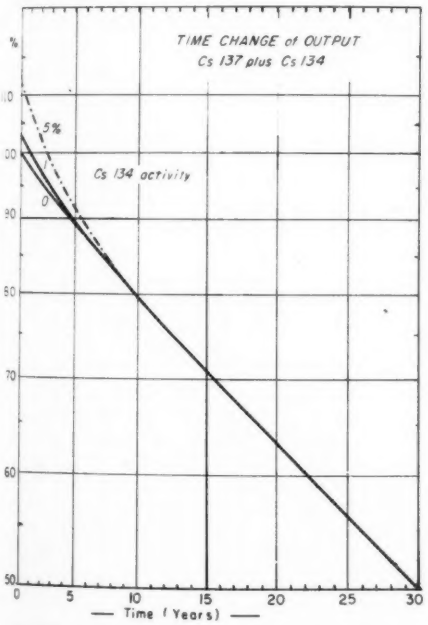

Fig. 6. Relation of decay to output for pure and mixed sources.

output by 2.5 per cent and 5 per cent increases the output by 12.5 per cent. In five years, however, the original 12.5 per cent increase due to Cs^{134} content has dropped almost to a 3 per cent increase. This must be recognized in correcting for output of the unit; indeed, recalibration is probably more reliable.

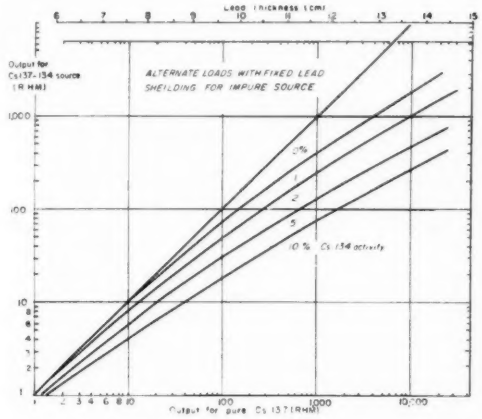

Fig. 5. Graph for calculating alternate loads for heads with a given lead shielding.

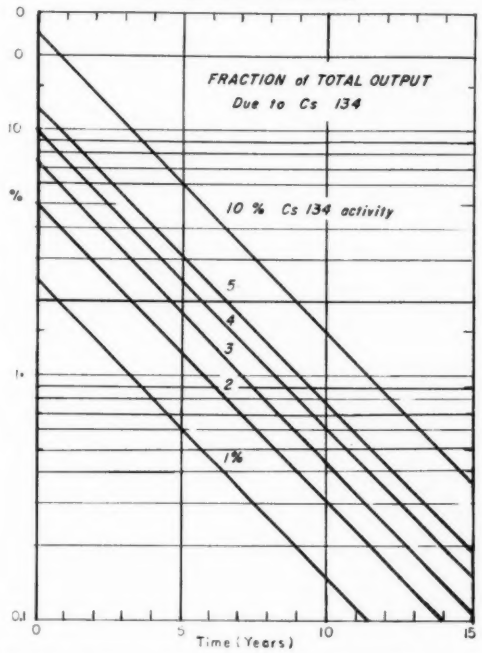

Fig. 7. Increase in output due to the addition of specific percentages of Cs^{134}.

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[1] Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

The Dual-Purpose Cesium Unit for Radiotherapy[1]

C. L. ASH, M.D., D. J. WRIGHT, Ph. D., and H. E. JOHNS, Ph. D.

Since cesium 137 has become available as a radiotherapy source, a variety of units have been developed. Two such units with an SSD of 15 and 35 cm., respectively, were built in the workshop of the Ontario Cancer Institute, Toronto, and have been in use for well over two years. To meet the needs of a general teaching hospital, a third unit was designed, combining certain features of the first two. It is capable of treating superficial tumors about the head and neck at 15 cm. SSD, or, alternatively, treating deep-seated lesions with an SSD of either 35 or 50 cm. It is this unit, now installed in the Department of Radiotherapy of the Toronto General Hospital, that is to be described.

The unit has two treatment ports (Fig. 1), directly opposite each other, one for treatment at an SSD of 15 cm. and the other at either 35 or 50 cm. Field sizes at 15 cm. are determined by a series of interchangeable lead cones, each weighing about 15 lb. This port is identical to that previously described by Whitmore and Johns (1). When the 35 or 50 cm. SSD is used, the cones are replaced by a lead safety plug. Field sizes at the longer SSD's are determined by a multi-leaf collimator, which may also be rotated about an axis coincident with the gamma-ray beam (Fig. 2). For use at 50 cm., extension bars are screwed to each side of the collimator and carry extendable penumbra trimmers at their distal ends. Lucite prisms on the ends of the collimator and extension bars keep the metal surfaces away from the patient and allow the fields to be set to skin markings.

The source is mounted in a wheel geared to rotate within a second wheel. In the schematic diagram (Fig. 3) the source is shown in the "off" position. To turn the unit on, opposite the lower opening for treatment at the longer SSD, both the large and small wheels are turned in the direction indicated by arrow B, thus bringing the source opposite the lower opening of the head. Conversely, rotation in the opposite direction from the "off" position will bring the source to position A at the top of the head. Both source wheels and the head are manufactured from "heavy met." The source is turned on by means of a motor mounted in the yoke, and turned off by reversing it. A weight is incorporated to act as a fail-safe mechanism in the event of power failure.

The source itself, nominally 600 rhm (2,000 curies) was obtained from Oak Ridge through Picker X-Ray Corporation, Cleveland, Ohio, and is contained in a modified international source capsule with a face 3.2 cm. in diameter.

The head is mounted in a yoke at the end of a telescopic tube capable of vertical motion of 3 feet. A pawl and rack mechanism provides a safeguard in case of cable breakage. The telescopic tube is hung

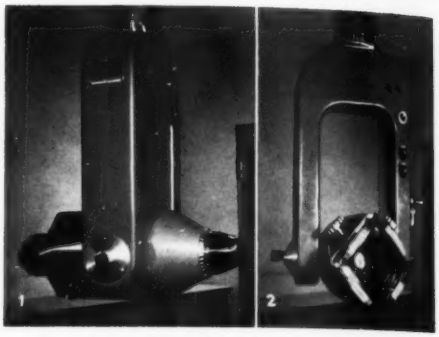

Fig. 1. Dual-purpose cesium unit.
Fig. 2. Multileaf collimator for determination of field sizes.

from a steel plate which can float on top of another plate when a very thin film of air at 30 lb. pressure is forced between them. This allows for a horizontal movement of the head of up to 4 inches in any direction.

The head may be rotated through 360° about a horizontal axis by means of a hand wheel to allow for the use of either treatment port. Actual treatment by either of these portals, however, is limited by a system of interlocks to an arc of 160° in the vertical plane and to 140° in the horizontal plane.

As with the teletherapy isotope equipment at the Ontario Cancer Institute, this unit has been provided with a special dose computer, which has previously been described (2). This computer has been modified to provide three basic timer speeds for each SSD, *i.e.*, 15, 35, and 50 cm. To operate the

TABLE I

CENTRAL AXIS PERCENTAGE DEPTH DOSE

CAESIUM^{137} 50 cm S.S.D.

Depth cm	Field Size cm x cm				
	6 x 6	8 x 8	10 x 10	15 x 15	20 x 20
0.15	100	100	100	100	100
1.0	94.9	95.0	95.1	95.5	95.7
3.0	79.9	81.5	82.7	84.0	84.2
5.0	66.3	68.7	70.8	72.9	73.9
8.0	49.1	51.4	53.7	57.1	58.0
10.0	40.0	42.2	44.5	48.2	49.5
12.0	32.7	34.8	36.8	40.5	42.3
15.0	23.7	25.7	27.8	31.4	33.0
20.0	14.2	15.4	17.0	20.0	21.5

device the technician must select the particular port, SSD, and field size, and set the required given dose. Indication of the port being used is provided on the control cabinet and electrical interlocks prevent selection of the wrong port. The computer counts down from the given dose to zero, at which point it shuts off automatically.

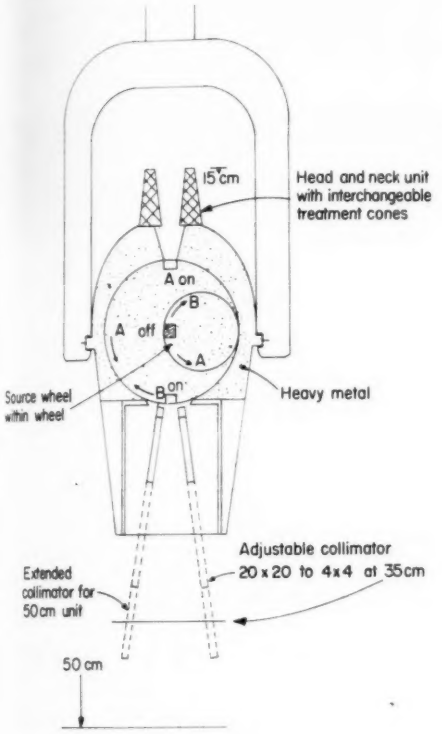

Fig. 3. Schematic drawing of cesium unit.

PHYSICAL MEASUREMENTS

Protection: With the unit in the "off" position, the maximum and average dose rates from the head are only about 50 per cent of those recommended in N.B.S. *Handbook 54*, being, respectively, 4.5 and 1.2 mr/hr. at 1 meter.

Depth Dose: Figure 4 shows the percentage depth dose which may be obtained at the three different treatment distances. To indicate both the build-up region and the variation of dose at greater depths the scale has been broken to extend from 0 to 4 mm. and from 0 to 20 cm. For the short SSD the depth dose rises from 90 per cent on the surface of the skin to 100 per cent at a depth of 1.5 mm. The dose then remains essentially constant to a depth of about 4 mm., where it falls off quite rapidly to reach 25 per cent at 10 cm.

With an SSD of 35 cm., the surface dose is about 65 per cent and the dose at 10 cm. 40 per cent of the maximum, which occurs at 1.5 mm. At an SSD of 50 cm., the surface and maximum doses are essentially the same, but the dose at 10 cm. depth is 45 per cent. Depth-dose tables for the 15 and 35 cm. SSD's are available (1, 3). Table I gives the depth dose *vs.* field size for 50 cm. SSD.

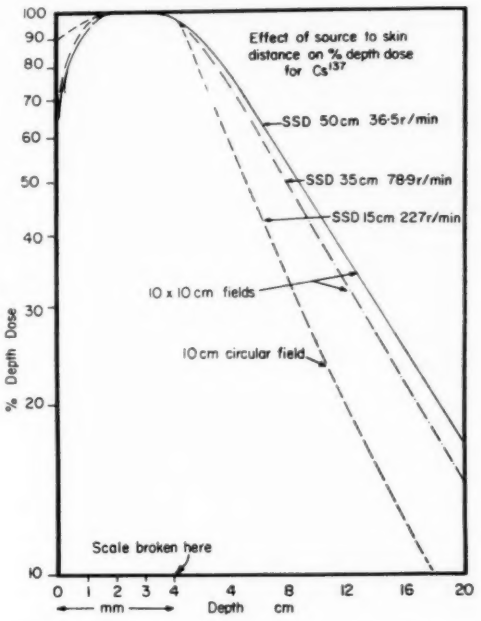

Fig. 4. Percentage depth dose at three treatment distances.

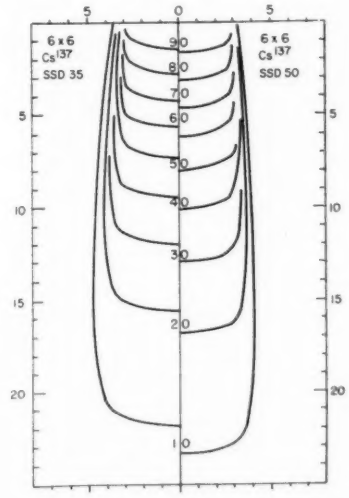

Fig. 5. Isodose curves for 35 and 50 cm. SSD.

Dose Rates: Dose rates for the three treatment distances are as follows.

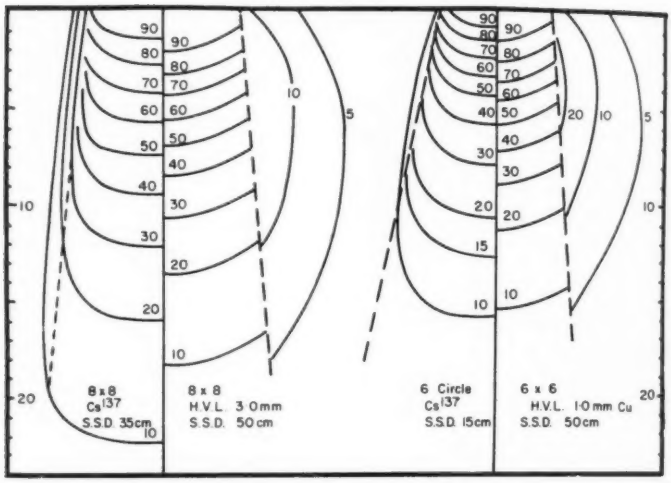

Fig. 6. Isodose curves for cesium compared with 250-kv x-rays.

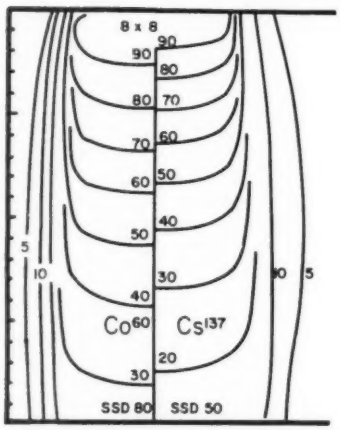

Fig. 7. Isodose curves for cobalt 60 at 80 cm. SSD and cesium 137 at 50 cm. SSD.

Field Size	SSD	Dose Rate
10 cm. circle	15 cm.	227
10 × 10 cm.	35 cm.	78.9
10 × 10 cm.	50 cm.	36.5

Isodose Curves: A selection of isodose curves for both 35 and 50 cm. SSD has been made with an isodose plotter built at the Ontario Cancer Institute. Curves for 35 cm. SSD were almost indistinguishable from those obtained earlier with the cesium unit at the Institute in spite of the larger source dimensions (3).

Figure 5 shows curves for a 6 × 6-cm. field at 35 and 50 cm. SSD. These indicate the increase in the depth dose and decrease in penumbra for 50 cm. as compared to 35 cm. SSD. The penumbral width between the 10 and 60 per cent contours at a depth of 5 cm. is decreased from 1.2 to 0.8 cm. in going from the 35 to the 50 cm. SSD.

Figure 6 shows the isodose curves obtained with cesium 137 operating at 35 cm. and x-rays with a half-value layer of 3.0 mm. Cu, at 50 cm. It should be noted that side-scatter from the cesium is very much less than with the 250-kv radiation. At small depths the 250-kv radiation gives a higher percentage depth dose because of the large amount of scatter. The two sources give about the same percentage depth dose at 5 cm., *i.e.*, 60 per cent, but from this point on that of cesium is higher because of the greater penetrating power of its irradiation. Comparing a cesium unit operating at 15 cm. with an x-ray machine of 250 kv and h.v.l. of 1.0 mm. Cu, it is noted that with the 250-kv beam the 5 and 10 per cent isodose curves lie far outside the geometric edge of the beam. Because of its short SSD, the cesium unit gives a higher percentage depth dose superficially, which is desirable in a head and neck unit.

A comparison of the isodose curves of cobalt 60 at 80 cm. SSD and cesium 137 at 50 cm. SSD shows the percentage dose with cesium to be about 10 to 12 per cent less than for cobalt (Fig. 7). It is therefore clear that cesium will never be a competitor of cobalt in producing a beam with a high percentage depth dose.

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Effect of Radiation on Metastatic Pelvic Lymph Nodes Judged by Pelvic Venograms[1]

SUMNER HOLTZ, M.D., WILLIAM E. POWERS, M.D., and ALFRED I. SHERMAN, M.D.

The proper management of any neoplasm depends upon accurate determination of its full extent. This applies not only to the primary lesion, but to metastases as well. While lymph-node metastases from some tumors lend themselves to inspection and palpation, node involvement from pelvic organs may remain hidden. Because of the frequency with which these pelvic nodes are involved, therapy has often been directed to include them even though in an individual case their true status is obscure.

Metastatic lymph nodes can be demonstrated by distortion of the opacified pelvic venous system (1-3). Demonstration of such metastases is not only of value prognostically but contributes to proper management of the neoplasm. Since many pelvic tumors are treated by irradiation, it should then be possible to use pelvic venography to disclose the effects of radiation on the metastatic nodes.

The draining lymph nodes from the pelvis lie along vascular channels, *viz.*, the hypogastric and the external and common iliac vessels, the inferior vena cava, and the aorta. The exact sites and the incidence of involvement depend upon the location of the primary lesion. Veins, being thin-walled and of low intraluminal pressure, are easily disturbed by the enlarged, firm cancerous lymph nodes lying adjacent to them.

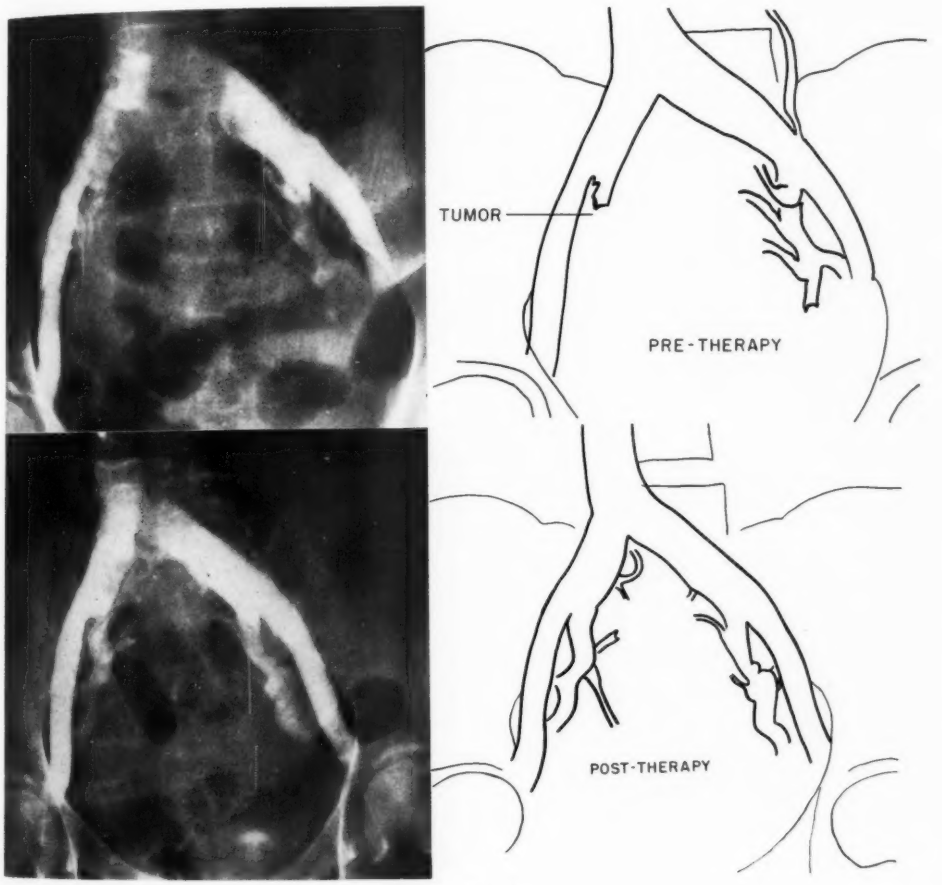

Fig. 1. Case I.

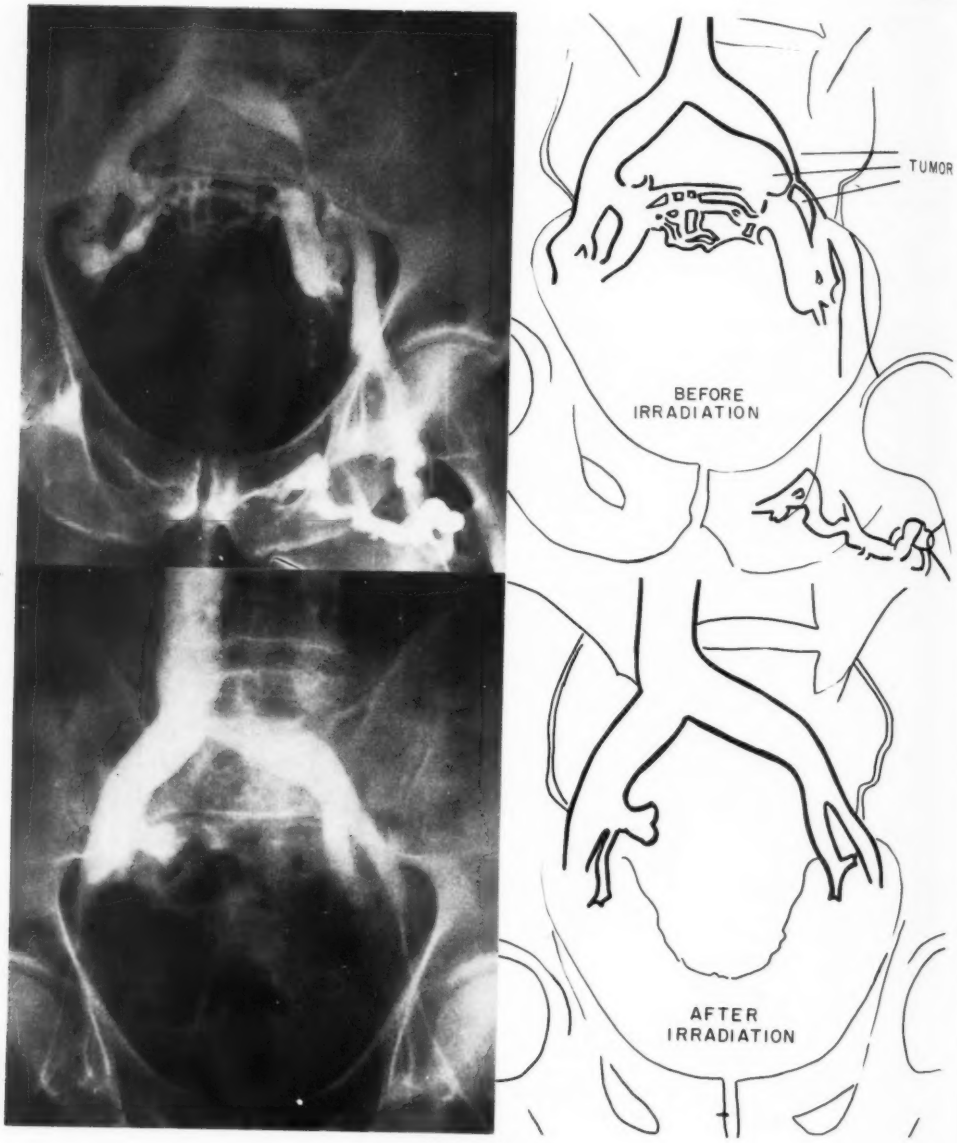

Fig. 2. Case II.

The technic of pelvic venography has been previously described, as has the normal and abnormal anatomy (1–3). This procedure consists in bilateral percutaneous catheterization of both femoral veins, with the catheter placed 10 cm. caudad to the junction of the external and internal iliac veins. Contrast medium is injected through each catheter rapidly, and serial films are obtained by means of a rapid film-changing device. The examination is carried out with the patient supine, and in two stages, with and without compression of the inferior vena cava. After this examination is completed, films of the urinary tract are made for excretory pyelograms. In our experience, there have been no significant complications (2).

The metastatic lymph nodes lying beside the low-pressured veins may indent or displace them or occlude the venous flow either in normal or retrograde direction. With obstruction there also may be filling of a collateral circulation. These criteria have been adequately established.

We have used pelvic venography to determine

response of the metastases to irradiation. At our institution, in the majority of patients with advanced carcinoma of the cervix, an extraperitoneal lymphadenectomy is performed after irradiation. Pelvic venography is part of the pretreatment work-up and is repeated after radiation therapy and prior to lymph node dissection. Since the status of the nodes is indicated on the initial venogram, the effect of treatment can be judged by comparison with the repeat venogram and by pathologic study. Similarly, in cases of recurrent carcinoma of the cervix being considered for exenteration, pelvic venography is performed before surgery; if the tumor is not resectable and is re-irradiated, the effects of irradiation can be assessed by repeat venograms. This same technic is used to judge the effects of irradiation on metastatic pelvic lymph nodes from carcinomas of the bladder, testicle, and uterus and retroperitoneal lymphomas, as demonstrated in the following two cases.

CASE I (Fig. 1): A 68-year-old woman entered the hospital with a ten-day history of vaginal bleeding. Biopsy of the cervix was reported as showing epidermoid carcinoma. On pelvic examination there was bilateral infiltration, fixed on the left. The pre-therapy pelvic venogram indicates failure of complete reflux into the right hypogastric vein, although reflux occurred on the left. The site of obstruction is irregular and without evidence of a thrombus or valve. The obstruction is due then to a metastatic lymph node. A repeat venogram two months after two radium applications and Betatron therapy (using a wedge) so that the node received 6,000 rads demonstrates normal reflux into both hypogastric veins. At the time of extraperitoneal lymphadenectomy, a slightly enlarged lymph node was found in the region of the previous obstruction; histologic examination showed radiation effect and suggested tumor-cell destruction.

CASE II (Fig. 2): A 64-year-old man entered the hospital because of swelling of the left leg of two months duration. On physical examination, there were found enlarged left inguinal nodes and a left lower abdominal mass. Inguinal node biopsy led to a diagnosis of Hodgkin's disease. Treatment was by irradiation, the tumor area receiving 3,500 rads. Immediately after therapy the edema of the leg receded. The pre-therapy venogram (done through the left side only) shows marked constriction of the left common and left external iliac veins and the left hypogastric vein, with collateral filling of the right pelvic veins. The venogram obtained one month after therapy demonstrates the return of the venous system to normal.

CONCLUSION

The response of metastatic lymph nodes in the pelvis to irradiation can be grossly demonstrated by pelvic venography.

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Radiophotoluminescent Gamma-Ray Dosimetry of Mixed Neutron Gamma-Ray Radiation Fields[1]

C. G. AMATO[2] and S. J. MALSKY[3]

Small solid state dosimeters are very attractive to radiologists, radiobiologists, physical scientists, and engineers. One proved solid detector is the radiophotoluminescent glass needle, 6 mm. long and 1 mm. in diameter, weighing 13.2 mg. Gamma or x-ray response of a properly *shielded* needle is energy-independent from 45 kv to 1.33 Mev. Above 1.0 Mev, the *unshielded* needle is considered energy-independent.

It may be possible to measure the gamma dose component due to simultaneous neutron and gamma irradiation by means of an unshielded "regular" needle, *i.e.*, not containing lithium (1–4). The characteristics permitting this type of measurement are: no fast neutron response, an accountable thermal and resonance neutron response, and additivity of response.

The energy absorption due to neutron activation was calculated and expressed in rads. This value, which is a function of the thermal and resonance neutron NVT, when subtracted from the gross needle reading, gives the gamma dose delivered to the needle.

The calculated value of the neutron component of the glass dose is based on these major assumptions: (*a*) Only the absorption of the betas emitted by decaying radiosilver is responsible for neutron-induced energy deposition in the needle. (*b*) Neutron capture gammas originating in the glass and silver decay gammas do not significantly contribute to the photoluminescence. (*c*) The average beta energy is taken to be one-third of the maximum beta energy. (*d*) All betas emitted are completely absorbed in the glass.

The average weight of silver in a regular needle is 546 micrograms. The two isotopes of silver following radioactive capture give rise to three radioisotopes: 2.3 m Ag^{108}, 270 d Ag^{110m}, and 24 s Ag^{110}. These isotopes emit seven betas having maximum energies ranging from 0.087 Mev to 2.86 Mev. Beta abundance varies from 3 to 100 per cent. These isotopes decay to stable isotopes of palladium.

At least four hours are permitted to elapse between exposure and reading of the photoluminescence, in order to permit decay of temporarily active centers and stabilization of the effect. In this time interval, Ag^{108} and Ag^{110} decay completely. The energy deposition due to these isotopes is given by:

$$ED_{108 \text{ or } 110} = VN\,\sigma_{ACT}\phi\bar{E}_{B}A\,w^{-1}\,1.6 \times 10^{-34} \quad (1)$$

where

N = number of Ag^{107} or Ag^{109} atoms per c.c.
σ_{ACT} = the activation cross section in barns
ϕ = time integrated activating flux in n/cm^2
$\bar{E}_B$ = average absorbed beta energy in Mev
A = beta abundance, in per cent
w = needle weight, in grams
ED = energy absorption, in rads.
V = needle volume in c.c.

The ED as defined in equation 1 must be summed to include activation of both isotopes due to thermal and resonance neutron activation.

The value of ED_{110m} due to long-lived Ag^{110} is:

$$ED_{110m} = N\sigma_{ACT}\phi\bar{E}_{B}Aw^{-1}\lambda\int_0^t e^{-\lambda t}\,dt\;1.6 \times 10^{-34} \quad (2)$$

where λ has its usual significance and t is time to reading.

In practice a plastic-covered needle is placed in proximity to neutron monitor(s) such as gold. Use of this technic may be shown by the following application: At the Brookhaven National Laboratory during an experiment, thermal NVT was 1.5×10^{13} $n/cm.^2$ delivered during 750 megawatt-seconds. The resonance flux is not significant. The neutron produced dose was:

rads from Ag^{108}	1653
rads from Ag^{110}	4
rads from Ag^{110m}	1566
TOTAL	3223

The gamma dose was obtained by subtraction.

4180	gross needle reading
−3223	neutron exposure
957	rads, gamma dose

Since the gammas are mostly high-energy neutron capture gammas, the energy response of the needle may be taken to be uniform with respect to gamma energy.

The validity of the second and fourth assumption, upon which the value of the glass energy absorption rests, must be tested. This is an analytical test and should be completed early in 1961. In addition, the average beta energy should be measured if a search of the literature fails to locate these data. If the gamma rays accompanying the neutrons are soft gammas, the unshielded needle may respond erroneously due to its energy dependence. This is not believed to be a factor at Brookhaven, since the gammas incident upon the needle are neutron capture gammas (most probable average energy 4.95 Mev) which have penetrated a thick bismuth shield.

This technic permits, probably for the first time, the convenient measurement of gamma dose delivered to a detector located in a neutron-gamma field.

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[3] Non-resident research collaborator.

Multiple Implant Dosimetry[1]

C. G. AMATO,[2] S. J. MALSKY,[3] V. P. BOND, M.D.,[4] B. ROSWIT, M.D.[5]
With the technical assistance of EVERETT HEINZE[6]

Low-atomic-number, silver-activated radiophotoluminescent glass-needle dosimeters were placed within a four-portal, 10-mil wall gold shield and implanted in a 38-pound dog. Over 150 needles were implanted, by a trocar technic (Fig. 1). Implants were made in three planes, so that most of the vital organs were pierced (Fig. 2). The shielded needles were placed in a PE-320 polyethylene tube. Spacing of 0.25 inch between needles was maintained by inserting plastic cylindrical spacers. An average of 50 needles located in at least three traverses, in the same plane, were exposed at a T.S.D. of 110 cm. to 260-kvp x-rays delivered at 30 ma, with 1 mm. Al and 0.5 mm. Cu filtration. A circular portal 7 cm. in diameter was used. At mid-exposure, the dog was turned over and the total exposure completed. The gold shield designed to achieve energy-independence (1, 2) is shown in the insert in Figure 1. The theory of this dosimeter and its response have been reported by the authors (3–7).

Prior to exposure for dosimetric reasons, lateral and anteroposterior diagnostic films were taken to locate the dosimeters. After all exposures were completed, an autopsy was performed to obtain positive positioning information and identity of all pierced vital organs. The shielded dosimeters can be replaced after exposure, since all dimensions are known and the diagnostic films permit accurate localization. The plastic tubes were never removed. A stylus was employed to clear the tubes upon completion of an experiment.

The needles were read with a reader designed by the Naval Research Laboratory and modified by the physics staff of the Radiotherapy Department, Kingsbridge VA Hospital. Readings were correlated with dosimeter position as given in the

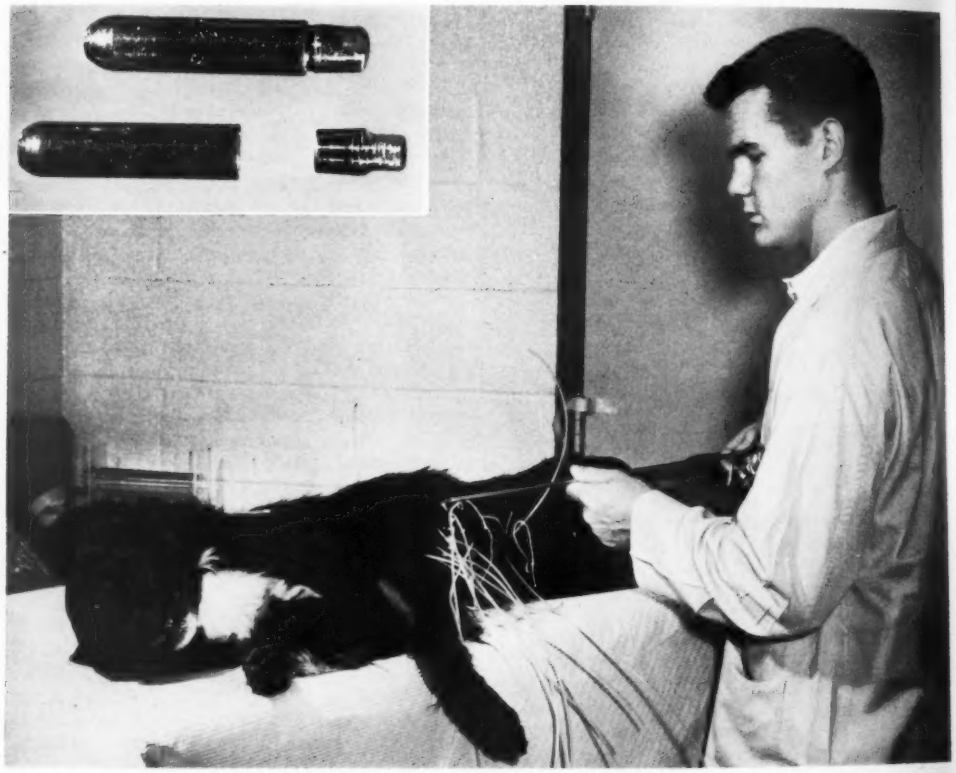

Fig. 1. Implantation of needle dosimeters by trocar technic. Insert shows gold-shielded needle. (Brookhaven National Laboratory Nos. 9-308-60 and 7-254-60).

Fig. 2. Implantation of needle dosimeters so that most of the vital organs were pierced. (Brookhaven National Laboratory No. 9-306-60.)

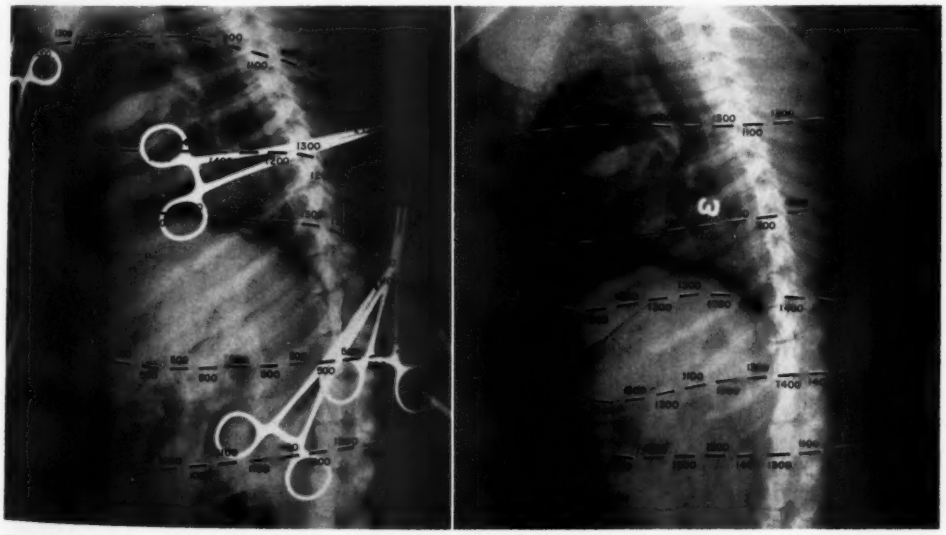

Fig. 3. Roentgenograms showing readings obtained. (Brookhaven National Laboratory Nos. 11-277-60 and 11-278 60.)

lateral films (Fig. 3). Results of preliminary experiments are encouraging, and complete data should be available by March 1961. Results should establish the feasibility of this mode of multiple implant dosimetry, confirm isodose patterns through experiment, and yield valuable depth-dose data.

AMF Atomics Laboratory
Industrial Reactor Laboratories, Inc.
Plainsboro, N. J.

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[1] From the Medical Department, Brookhaven National Laboratory, Upton, N. Y. Work supported by the U.S.A.E.C. Presented at the Forty-Sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

[2] Resident research collaborator. Now at AMF Atomics Laboratory, Industrial Reactors Laboratory, Plainsboro, N. J.

[3] Non-resident research collaborator.

[4] Head of Microbiology Division, Medical Department, Brookhaven National Laboratory.

[5] Chief, Department of Radiation Therapy, Bronx VA Hospital, Bronx, N. Y.

[6] Now at Cornell University Medical School, New York, N. Y.

An "Ideal" in Vivo Dosimetry System for Clinical and Experimental Radiation Therapy[1]

B. ROSWIT, M.D., S. J. MALSKY, C. G. AMATO, C. B. REID, L. MADDALONE, and C. SPRECKELS

This is a progress report on the development of an "ideal" *in vivo* dosimetry system for both experimental and routine clinical use in radiation therapy of cancer. During rigorous clinical studies this system has thus far proved to be unusually dependable, practical, versatile, and economical to operate. It has been applied in nearly every anatomical structure in living subjects. Further, it is promptly available for general application in clinical practice.

The basic dosimeter consists of a tiny photoluminescent glass rod (1 × 6 mm.) encased in a miniature gold cartridge which we designed (1.6 × 10 mm.), with a removable screw-cap. Placed within or upon the body and exposed during radiation therapy, the glass rod may be removed at any time and "read" in a chamber which may be easily constructed or purchased from the commercial source which now supplies the glass rods.[2] Unlike other dosimeters, "reading" does not discharge the unit and it may be replaced in the body for cumulative dose recording as high as 20,000 r (or as low as 20 r). This recording is permanent until erased by a simple heating procedure.

We have employed these gold-shielded dosimeters successfully in nearly every body tissue and space in cancer patients receiving ionizing radiation from almost every kind of source, including 260 kv to 2,000-kv apparatus, cobalt 60, cesium 137, radium, radon, and iridium 192. In the Radiation Clinic, the gold-shielded glass rod reads accurately to within ±5 per cent; in the laboratory, within ± 2 per cent. Complete energy independence was noted in the range employed, so that this dosimeter does not have to be calibrated against each specific therapy source. For this advantage, and many others, the gold shield is indispensable. Without it, for example, there is striking energy dependence (and unreliability) below the supervoltage energy range; when portals are larger than 150 sq. cm.; and in tissue depth greater than 8 cm. When utilized in the bare state, the glass rods are not identifiable and are easily contaminated, chipped, and cracked, delivering false readings.

We have positioned the gold-shielded microdosimeter in the heart, brain, paranasal sinuses, nasopharynx, pharynx, tongue, floor of mouth, lymph nodes, mandible, and skeleton. We placed the tiny chamber in the esophagus, larynx, trachea, bronchi, stomach, colon, rectum, renal pelvis, ureter, urethra, bladder, uterus, cervix, parametrium, prostate, mediastinum, aorta, vena cava, and in the general vascular system accessible to catheterization.

For most applications, a common No. 8 polyvinyl feeding catheter has been found quite adequate, with dosimeters loaded singly or in tandem. For interstitial use, a large-bore needle was designed to carry the polyvinyl catheter or a hollow radium needle of appropriate length was employed. The latter was found especially valuable for reaching points A and B in the parametrium during radium therapy for cancer of the cervix. Indeed, one can take a reading at point A with a dosimeter in the #8 polyvinyl catheter placed in the ureter at the correct anatomical level. The Foley and Friedman-Lewis catheters were used in the bladder, the Miller-Abbott in the small bowel, and special catheters were designed for other anatomical sites.

There is virtually no tissue or space impregnable to the microdosimeter. The possible applications are limited only by the imagination, ingenuity, and skill of the clinical therapy team.

This system of *in vivo* dosimetry has thus far served us well in an effort to improve our treatment planning; to compare our calculated dosage with actual dose received by the tumor or critical tissue; to assess the quality of the therapy technic; to evaluate proposed methods for patient immobilization and beam orientation; to study inhomogeneity problems in bone and lungs; to study clinical dosimetry with megavoltage x-rays, electron beams, neutron-gamma beams and a variety of radioactive isotopes. These intriguing investigational areas remain to be further explored.

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[1] From the Department of Radiation Therapy, Bronx Veterans Administration Hospital, Bronx, N. Y. Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

[2] Bausch & Lomb Optical Co., New York, N. Y.

EDITORIAL

H. Milton Berg, M.D.

President of the Radiological Society of North America

It is a remarkable tribute to opportunity in the United States that two men from a modest clinic in a very small city, in one of the least populated states of the Union, should, in the same year, be elevated to two of the highest offices which can be conferred upon a physician in this country. I refer to Dr. Leonard W. Larson, who is President of the American Medical Association, and to our own Dr. H. Milton Berg, President of the Radiological Society of North America. For both are members of the Quain and Ramstad Clinic in Bismarck, North Dakota.

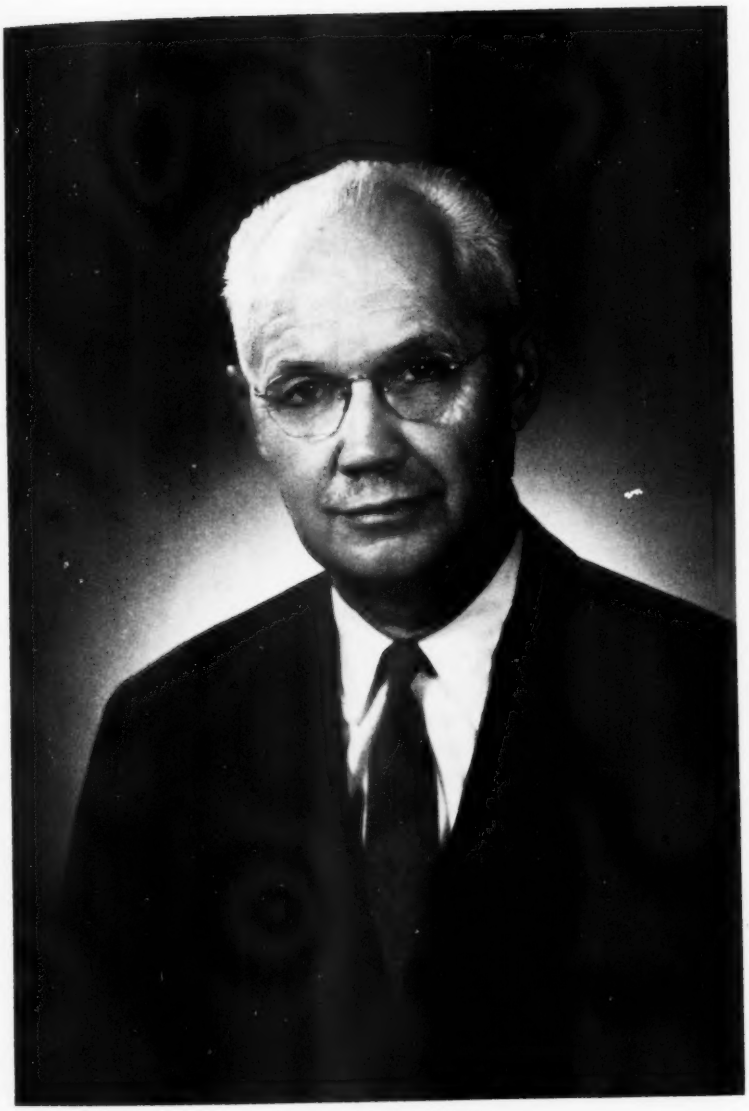
Dr. Berg was born on Feb. 27, 1902, in North Dakota. He received his premedical and medical education at the University of Minnesota, which conferred on him the degrees of Bachelor of Science, Bachelor of Medicine, and, in 1925, Doctor of Medicine. He served his internship in the Minneapolis General Hospital, where he came under the influence of the radiologist and developed the interest in the field which was to govern his future life activity. After several years of practice in internal medicine, he undertook further training in radiology with Dr. Preston Hickey at the University of Michigan and with Drs. Stenstrom and Rigler at the University of Minnesota. After completion of this period, he moved to Bismarck and became Chief of the Department of Radiology at the clinic and hospital which he has continued to serve to this day. In 1936 and 1937, he studied in Europe, especially in Sweden. He repeated this visit in 1948, and has retained a close association with Scandinavian radiology throughout the years.

Dr. Berg has devoted his unstinting energies and tireless efforts to the advancement of medicine, and particularly of radiology. As a result, he has been honored with many offices in various medical societies. I would mention only that he has been President of the North Dakota Radiological Society, the Minnesota Radiological Society, the Rocky Mountain Radiological Society, and of the Sixth District Medical Society. He was elected to the Board of Directors of the Radiological Society of North America in 1955. His distinguished services to the Society culminated in his election as President.

Over the years, he has conducted a residency training program. When he was a member of the faculty of the Department of Radiology at the University of Minnesota, he exhibited well his interest and facility in teaching. He has made a number of substantial contributions to the scientific literature. Above all, he has been an interested and active participant in radiological meetings, bringing to their proceedings a wealth of wisdom and good judgment.

An enthusiastic hunter, fisherman, horseman, and nature lover, Milt Berg has shared his opportunities in this respect with many prominent physicians in the United States. Anyone who came as a guest lecturer or teacher at the University of Minnesota, or to North Dakota, had a standing invitation to hunt or fish under his guidance.

In 1925 Dr. Berg was married to Alberta Nörreen Kaiser, who has been a wonderful helpmate throughout his active years.



H. MILTON BERG, M.D.

President of the Radiological Society of North America

The Bergs have two children, Dr. Roger, who is also a radiologist, practicing with his father, and Albert, who is a pilot.

The Presidency of the Society is in good, steady hands. The membership can be confident that its course will be straight and its progress upward under its new leader.

LEO G. RIGLER, M.D.

The Forty-Sixth Annual Meeting

The Forty-sixth Annual Meeting of the Radiological Society of North America was held in Cincinnati, Ohio, at the Netherland Hilton Hotel, Dec. 4–9, with a registration of approximately 3,000 persons. The meeting was of unusual scientific excellence. The program, which was arranged by the President, Dr. Theodore J. Wachowski, and his committee, covered a wide range of subjects, while the refresher courses, planned by Dr. John W. Walker's committee, offered instruction in practically all phases of radiology. The scientific exhibits were outstanding and the commercial exhibits (listed in RADIOLOGY for November) met the usual high standards.

Sunday afternoon and evening and the early hours of each day thereafter were set apart for refresher courses. The Sunday afternoon therapy course, with Dr. Don G. Mosser as moderator, attracted a good attendance and the discussion was stimulating. In the evening, the Pavillon Caprice was filled to capacity for the film interpretation course, under the skillful direction of Dr. Bernard J. O'Loughlin.

The meeting was formally opened by the President on Monday afternoon. Dr. Robert E. Howard, President of the Cincinnati Academy of Medicine, delivered an Address of Welcome, calling attention to some of the early radiological achievements to which the city could lay claim.

In particular he mentioned a paper on x-ray treatment of the enlarged thymus presented before the Cincinnati Academy of Medicine in 1907, the pioneer work of Dr. Samuel Iglauer on the diagnosis of perforations of the esophagus by foreign bodies, and the contributions of Dr. Sidney Lange to study of the mastoid.

Following Dr. Howard's address, Dr. Cesare Gianturco, First Vice-President, then assumed the chair, while Dr. Wachowski delivered his Presidential Address—"Some Logistics of the Radiological Society of North America, with Thoughts About the Future." Following this, Dr. Leo G. Rigler introduced the Memorial Fund Lecturer, Dr. Payne S. Harris of Los Alamos, who spoke on "Radiation in Outer Space: Natural and Man Made," setting forth some of the problems incident to the development of rockets and space travel. Appropriately, the remaining papers of the session were devoted to radiation exposure and protection, concluding with a presentation of the legislative aspects by Dr. Carey Brewer of Washington, D. C.

On the subsequent mornings, diagnostic sessions were held, paralleled by sessions devoted variously to radiobiology, isotopes, and physics. A similar plan was followed for the afternoons, with sections on diagnosis, physics, and therapy meeting simultaneously. The total number of papers presented, not including those on Friday, was 85. In accordance with a plan initiated the preceding year, that morning was given over to Work in Progress, with brief accounts of current studies related to diagnosis and therapy. Most of these papers will be found in the present issue of RADIOLOGY under the heading Work in Progress.

At Tuesday morning's diagnostic session a panel discussion on gastrointestinal diseases, with Dr. Richard H. Marshak as moderator, attracted much favorable comment from a capacity audience. Papers on specific problems involving the digestive tract completed the program. The concurrent session was given over to the radiobiologists, with papers on various aspects of this special field. The diagnostic papers offered Tuesday afternoon included essays on myelography, the skull, and pediatric problems. At the same time the therapists were listening to presentations pertinent to their specialty, with particular attention to the technical aspects of radioactive needles and wires.

Cardiovascular problems were considered on Wednesday morning, with some emphasis on aortography and other angiographic procedures. At the session on

isotopes held during the same period attention was called to the expanding interest in this subject and the part taken by radiologists in developing it. In the afternoon diagnostic section, attention centered on bone lesions. Of unusual interest was a paper by Dr. Ronald O. Murray of London, England, on the osseous changes in Cushing's disease and following steroid therapy. The second session on this afternoon was devoted to the Physics

Dr. Thomas B. Bond receiving the Gold Medal of the Radiological Society of North America from the President, Dr. Theodore Wachowski.

Work in Progress program arranged by Dr. Warren Sinclair.

The diagnostic session on Thursday morning was devoted largely to urologic problems, with emphasis on the angiographic aspects. An interesting paper by Dr. John A. Campbell evaluated the role of film size in cineradiography. The concurrent physics section was for the most part concerned with dosage measurements and isodose curves. The three afternoon sessions included a variety of papers on diagnosis, treatment, and physics.

The Carman Lecture, on Thursday evening, was delivered by Dr. Warren H. Cole, of Chicago. Cole, who was one of the originators of cholecystography, gave a historical review of this epoch-making development, interspersing his more serious remarks with touches of humor which evoked an enthusiastic response from his hearers. At the close of the lecture Dr. Cole was presented with an illuminated scroll commemorating the occasion and was also awarded the Gold Medal of the Society in recognition of the great service which he and his co-workers performed for radiology by producing the first cholecystograms. A Gold Medal was presented also to Dr. Tom Bond of Fort Worth, Texas, for his long service to radiology and, in particular, to the Radiological Society of North America. A special presentation of a silver tray suitably inscribed was made to Dr. Howard P. Doub as an expression of appreciation of his twenty years of service as Editor of RADIOLOGY.

Dr. Howard P. Doub receiving from Dr. Theodore Wachowski a silver platter in recognition of twenty years service as Editor of Radiology.

Following these presentations, announcement was made of the award for the scientific exhibits and of the new officers of the

Society. The scientific exhibits are listed below with mention of those receiving special honors. The new officers are as follows: President, H. Milton Berg, M.D., Bismarck, N. D.; President Elect, Charles M. Gray, M.D., Tampa, Fla.; First Vice-President, Philip J. Hodes, M.D., Philadelphia, Penna.; Second Vice-President, John R. Hodgson, M.D., Rochester, Minn.; Third Vice-President, George Cooper, Jr., M.D., Charlottesville, Va.; Treasurer, Dwight V. Needham, M.D., Syracuse, N. Y.; Secretary, Maurice D. Frazer, M.D., Lincoln, Nebr.; Historian, Howard P. Doub, M.D., Detroit, Mich. The new member named to the Board of Directors is John W. Walker, M.D., Kansas City, Mo. Dr. Ivan J. Miller, of San Francisco, becomes the Chairman of the Board.

The last official act of Dr. Wachowski as President consisted in turning over the Pfahler gavel to Dr. H. Milton Berg, the incoming President. Dr. Berg then presented Dr. Wachowski with an illuminated scroll commemorating his term as President of the Society.

Few who attended the meeting did not feel the void created by the death of Dr. Donald S. Childs, who served the Society for so many years as Secretary-Treasurer and was in large part responsible for the success of previous meetings. His skilful guidance of the affairs of the organization and his wisdom and experience will long be missed. To Dr. Wachowski, upon whom devolved many of the problems in connection with the physical arrangements for the meeting as well as its scientific aspects, heartiest congratulations are due.

The Scientific Exhibits

The Scientific Exhibits at the Annual Meeting in Chicago, Dec. 4–9, 1960, were displayed in separate rooms on two floors of the Netherland Hilton Hotel. In addition to the more formal exhibits, interesting devices were shown in Gadget Row by Dr. Julius G. Baron of Iowa City, Iowa, Dr. Theodore F. Hilbish of Bethesda, Md., Dr. Herbert H. Virden of Kansas City, Mo., and Dr. Karl A. Youngstrom, of Kansas City, Kans. The Pfahler Gavel, presented to the Society by the late Dr. George E. Pfahler in 1930, held a position of honor.

The Case of the Day was presented by members of the University of Cincinnati Department of Radiology—Dr. Donald Dietrich, Dr. Harold B. Spitz, and Dr. John J. Schlueter. Dr. Irving I. Lomhoff of the Kaiser Foundation Hospital, Oakland, Calif., was the only four-time winner of this really difficult diagnostic test.

The following awards were made by the Secret Committee:

Magna Cum Laude

Exudative Enteropathy. RICHARD H. MARSHAK, M.D., HENRY JANOWITZ, M.D., BERNARD S. WOLF, M.D., NATHANIEL COHEN, M.D., New York, N. Y.

Cum Laude

Vulnerability to Stroke Evaluated by Angiography. BUELL C. BUCHTEL, M.D., HOMER D. KIRGIS, M.D., New Orleans, La.

Certificate of Merit

Study of Colon by Use of High-Kilovoltage Spot-Compression Technic—Results and Follow-up. STEVEN J. FIGIEL, M.D., LEO S. FIGIEL, M.D., FRED K. WIETERSEN, M.D., Detroit, Mich.

Method of Analysis for Evaluation of Treatment in Oropharynx Cancers and Cancer of the Cervix. GILBERT H. FLETCHER, M.D., PAUL M. CHAU, M.D., ELEANOR J. MACDONALD, Houston, Texas.

A Method of Treatment for Breast Carcinoma with Cobalt 60 Teletherapy Radiation. GEORGE P. KOECK, M.D., WILLIAM Y. TENZEL, M.D., LILLIAN E. JACOBSON, M.A., WILLIAM HILLSINGER, B.S., Newark, N. J.

The Pulmonary Arteries and Veins; Their Roentgen Identification. JOHN H. HARRIS, JR., M.D., F. B. MARKUNAS, M.D., J. H. HARRIS, SR., M.D., Carlisle, Penna.

Pelvic Pneumography: An Adjunct to Clinical Examination. G. MELVIN STEVENS, M.D., RICHARD S. LEE, M.D., JOHN F. WEIGEN, M.D., Palo Alto, Calif.

Honorable Mention

Long-Term Effects of Radiation in an Aging Population of Male Rats. D. C. JONES, Ph.D., D. J. KIMELDORF, Ph.D., San Francisco, Calif.

Two Vascular Grooves of the External Table of the

Skull. YOSH MARUYAMA, M.D., HERBERT SCHUNK, M.D., Boston, Mass.

The Use of Dental Materials in Radiotherapy. MELVIN L. GRIEM, M.D., GEORGE W. BARNHART, C.D.T., Chicago, Ill.

The Expanding Usefulness of Radiology in the Medical School Curriculum. LUCY FRANK SQUIRE, M.D., Rochester, N. Y.

Respiratory Distress in the Newborn. WILLIAM H. R. HOWARD, M.D., DONALD M. HOSIER, M.D., CHARLES R. MCCLAVE, M.D., Columbus, Ohio.

Neonatal Intestinal Obstruction. JOHN W. HOPE, M.D., MILTON L. WAGNER, M.D., KLAUS M. BRON, M.D., Philadelphia, Penna.

The Lower Urinary Tract in Infants and Children. LAWRENCE A. DAVIS, M.D., R. LICH, JR., M.D., L. HOWERTON, M.D., W. JOULE, M.D., Louisville, Ky.

The Roentgen Manifestations of Abnormal Bile Flow. OSCAR M. WEAVER, JR., M.D., Welch, W. Va.

Special Award

Medical Lessons of the Past—Prologue to the Future. COL. JOHN BOYD COATES, JR., MC (M.D.), LT. COL. LEONARD L. COLLIER, MSC (M.Sc.) Washington, D. C.

The other exhibits shown were as follows:

More Exact Localization in Congenital Hip Dislocations by Laminagraphy. WILLIAM S. ALTMAN, M.D., VITTALIANO MORACE, M.D., Quincy, Mass.

The Effects of Total-Body Irradiation on Some Aspects of Human Iron Metabolism. J. ROBERT ANDREWS, M.D., JACK LEVIN, M.D., KIRKLAND C. BRACE, M.D., Bethesda, Md.

Angiography in Strokes. HILLIER L. BAKER, JR., M.D., GEORGE E. PLUM, M.D., ARTHUR H. BULBULIAN, Rochester, Minn.

Difficulties in the Roentgen Diagnosis of Cecal Malignancy. CHARLES BERNSTEIN, M.D., NORMAN HEILBRUN, M.D., Buffalo, N. Y.

Cor Pulmonale in Infants and Children. DELBERT E. BOBLITT, M.D., JOHN F. HOLT, M.D., NORMAN S. TALNER, M.D., Ann Arbor, Mich.

Safe Radiography of Infants. DONALD B. DARLING, M.D., Pittsburgh, Penna.

Combined Radiologic and Gastroscopic Evaluation of Gastric Ulceration. GERALD D. DODD, M.D., ROBERT S. NELSON, M.D., Houston, Texas.

Corrected Transposition of the Great Vessels—Roentgenographic Anatomic and Functional Considerations. KENT ELLIS, M.D., BEVERLY C. MORGAN, M.D., DOROTHY H. ANDERSEN, M.D., New York, N. Y.

New Technic for Accurately Projecting the Dorsum Sellae into the Foramen Magnum. LEWIS E. ETTER, M.D., Pittsburgh, Penna.

Cobalt Teletherapy Depth Dose Corrections as Determined by Transmission Dosimetry. JOHN C. EVANS, M.D., R. J. SCHULZ, M.Sc., Bronx, New York.

Occlusion of the Superior Mesenteric Artery. BENJAMIN B. JACKSON, M.D., Louisville, Ky.

New Diagnostic Aids in Primary Carcinoma of the Ureter. RICHARD M. FRIEDENBERG, M.D., HARRY S. BERGMAN, M.D., VICTOR SAYEGH, M.D., Bronx, New York.

Perigastric Adhesions Simulating Carcinoma of the Stomach. ABRAHAM GEFFEN, M.D., FRIEDA FELDMAN, M.D., New York, N. Y.

Renal Arteriography. MORDECAI HALPERN, M.D., EDWARD I. GOLDSMITH, M.D., NATHANIEL FINBY, M.D., New York, N. Y.

Internal Mammary Implants. ULRICH K. HENSCHKE, M.D., BASIL S. HILARIS, M.D., EDWARD HOLODNY, B.S., New York, N. Y.

Radiological Uses of the Radiation Polymerization Dosimeter (Radiopol Dosimeter). FRANK E. HOECKER, Ph.D., HOMER L. HIEBERT, M.D., Lawrence, Kans.

Examination of Patients with Perforated Peptic Ulcer Using a Water-Soluble Contrast Medium. GEORGE JACOBSON, M.D., HARVEY I. MEYERS, M.D., CLARENCE J. BERNE, M.D., LEONARD ROSOFF, M.D., Los Angeles, Calif.

Effects of Voluntary Splitting on the Cervical Spine. JOHN H. JUHL, M.D., G. W. ROBERTS, M.D., S. M. MILLER, M.D., Madison, Wisc.

Lymphangiosarcoma in the Lymphedematous Arm. GEORGE P. KEEFER, M.D., JACOB H. VASTINE, 2ND, M.D., Philadelphia, Penna.

The Navy Radiation Exposure Evaluation Laboratory. CAPT. E. R. KING, MC, USN, Bethesda, Md.

Craniosynostosis. CAPT. HARRISON W. KNUDSEN, USAF, MC, Lackland Air Force Base, Texas.

Skin and Subcutaneous Reactions Induced by Supervoltage Cobalt-60 Irradiation. LEONARD M. LIEGNER, M.D., NORMAND J. MICHAUD, B.Sc., New York, N. Y.

Cholangiography. JOSEPH J. LITSCHGI, M.D., KARL A. MEYER, M.D., PETER A. ROSI, M.D., NICHOLAS J. CAPOS, M.D., Chicago, Ill.

Ureteritis Cystica and Pyelitis Cystica. BERNARD S. LOITMAN, M.D., HAROLD CHIAT, M.D., JOHN A. EVANS, M.D., New York, N. Y.

Laceration of the Liver Due to Nonpenetrating Trauma. JAMES J. MCCORT, M.D., San Jose, Calif.

Cardiac Laminagraphy. KENNETH D. MCGINNIS, M.D., Lexington, Ky., WILLIAM R. EYLER, M.D., HERNAN ALVAREZ, M.D., Detroit, Mich.

Pituitary Destruction with Y^{90}: Present Status. ROBERT D. MOSELEY, JR., M.D., PAUL HARPER, M.D., Chicago, Ill.

Intercalative Angiography. WILLIAM P. MURPHY, JR., M.D., ROBERT J. BOUCEK, M.D., FRANCISCO A. HERNANDEZ, M.D., Miami, Fla.

Versatility of Electron Beam Treatment Planning (Betatron 6–24 Mev). RICHARD F. NELSON, JOHN S. LAUGHLIN, Ph.D., JORGE GASPAR LANDERO, M.D., New York, N. Y.

Percutaneous Catheterization for Left Heart Visualization. LEON A. PHILLIPS, M.D., MELVIN M. FIGLEY, M.D., ROBERT A. BRUCE, M.D., LEONARD A. COBB, M.D., WERNER E. SAMSON, M.D., Seattle, Wash.

Atherosclerosis of the Aorto-iliac System: Aortographic Pathology. STANLEY M. ROGOFF, M.D., JAMES A. DEWEESE, M.D., RICHARD GERLE, M.D., Rochester, N. Y.

Congenital X-Irradiation Exencephaly. ROBERTS RUGH, Ph.D., New York, N. Y.

Autotomography in the Demonstration of Mid-Line Ventricular Structures and Basal Cisterns. MANNIE M. SCHECHTER, M.B., C. G. DE GUTIERREZ-MAHONEY, M.D., New York, N. Y.

Lesions Presenting in Right Cardiophrenic Angle. HILDEGARDE SCHORSCH, M.D., KI EUN CHUNG, M.D., Chicago, Ill.

Postbulbar Duodenal Ulcer. WENDELL P. STAMPFLI, M.D., HOWARD E. WILSON, M.D., Denver, Colo.

Caffey's Disease: Ten Cases in Two Generations of One Family. JOHN P. TAMPAS, M.D., F. W. VAN BUSKIRK, M.D., O. S. PETERSON, JR., M.D., Burlington, Vt.

Radiographic Examination of the Vocal Cords. SOL M. UNGER, M.D., GEORGE A. MEYER, M.D., HAROLD G. JACOBSON, M.D., MAXWELL H. POPPEL, M.D., H. KOLSON, M.D., Bronx, N. Y.

Forward Aortography. WILLIAM V. WELDON, M.D., LONGSTREET C. HAMILTON, M.D., ALFONSO ZERBI-ORTIZ, M.D., Washington, D. C.

Utilization of Direct Positive Diazo Reproductions of Roentgenograms. WALTER M. WHITEHOUSE, M.D., ROBERT RAPP, M.D., ARTHUR C. KITTLESON, M.D., Ann Arbor, Mich.

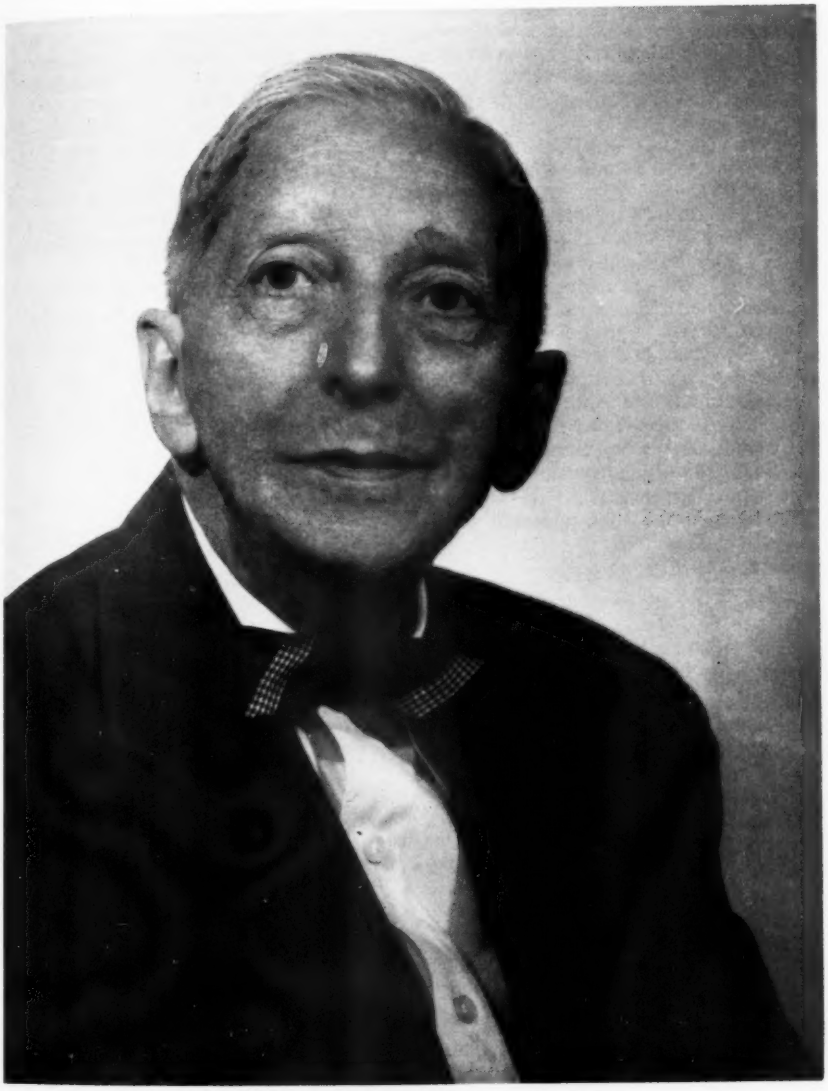
A Patient Propulsion Procedure for Aorto-arteriography. RUSSELL WIGH, M.D., WILLIAM F. LINDSEY, M.D., JACK MORGAN, B.S., WINFORD H. POOL, JR., M.D., Augusta, Ga.

Smooth Muscle Tumors of the Gastrointestinal Tract. DONALD A. WOLFEL, M.D., JAMES A. LYON, JR., M.D., Baltimore, Md.

Roentgen Aspects of Ascariasis. J. H. WOODRUFF, JR., M.D., B. H. FEDER, M.D., Torrance, Calif.

The Lower Esophageal Vestibular Complex: An Anatomic-Roentgen Study. COSTANTINO ZAINO, M.D., MAXWELL H. POPPEL, M.D., HAROLD G. JACOBSON, M.D., HAROLD LEPOW, M.D., CAHIT H. OSTURK, M.D., New York, N. Y.

IN MEMORIAM



BERTRAM CHARLES CUSHWAY, D.D.S., M.D.

1873–1960

Dr. Bertram C. Cushway, an emeritus member of the Radiological Society of North America, with which he became associated in 1919, died on Oct. 12, 1960.

Dr. Cushway was born on Mackinac Island, Michigan, on Oct. 25, 1873, son of Alfred G. and Emma Cordelia (Dingman) Cushway. He was graduated from the Northwestern University Dental School, D.D.S., in 1900 and from Northwestern University Medical School, M.D., in 1903.

Dr. Cushway's medical career began with internship at Chicago Wesley Hospital, 1904–1905. He was Assistant in Surgery to Drs. W. Van Hook and A. B. Kanavel at Northwestern University from

1905 to 1912; Assistant Instructor in Clinical Surgery, Post-Graduate Medical School, from 1906 to 1908 and Instructor in Surgery and Radiology until 1912; Instructor in Radiology and Radiologist at the Post-Graduate Medical School and Hospital from 1912 to 1933. He was also active in teaching at Loyola University Medical School of Chicago, where he became Associate Professor of Radiology in 1926.

In partnership with Dr. Roe J. Maier, Dr. Cushway practiced Radiology in private offices in the downtown area of Chicago from 1925 until 1930 and then on the South Side until his retirement in January 1957. With Dr. Maier, he devoted most of his time to hospital appointments. He became Radiologist at St. Bernard's Hospital in 1921; Evangelical Hospital, 1924; and St. George's Hospital, 1940. He served in a similar capacity in Englewood Hospital from 1930 to 1949.

Dr. Cushway belonged to the leading Radiological Societies and was President of the Chicago Roentgen Society in 1929–1930. His greatest devotion was to the Radiological Society of North America and he gave much of his time to numerous committee appointments in that organization. He was particularly interested in the education and welfare of x-ray technicians, aiding in the formation of their Registry within the Radiological Society of North America, and later promoting the establishment of their own National Registry. In appreciation of his efforts and support, he was granted honorary membership in the American Society of X-Ray Technicians in 1950. He was also active in the affairs of the Chicago Rotary Club.

While not a prolific writer, Dr. Cushway, alone and in collaboration with Dr. Roe J. Maier, contributed a number of stimulating scientific articles on radiologic subjects. He was the author of *Science of Radiology*, published in 1924 and used as a textbook in the course in Radiology at the Post-Graduate Hospital, Chicago.

An able teacher and radiologist, Dr. Cushway displayed a quiet kindness and outstanding diplomacy that endeared him to his patients, students, and colleagues.

Dr. Cushway was married in 1922 to Carrie May Buff, who died in 1945. In 1953 he married Mrs. Marie S. (Smola) Ewald, who survives him. A son of the earlier marriage, Bertram Charles Cushway, Jr., is a lawyer in Atlanta, Ga.

ROE J. MAIER, M.D.
ELBERT K. LEWIS, M.D.

ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN CLUB OF THERAPEUTIC RADIOLOGISTS

At its recent meeting in Cincinnati, the American Club of Therapeutic Radiologists elected Milton Friedman, M.D., of New York, its President. Other officers are: Manuel Garcia, M.D., New Orleans, Vice-President; J. A. del Regato, M.D., 2215 North Cascade Avenue, Colorado Springs, Colo., Secretary. The next meeting will be in Colorado Springs on May 13, 1961.

DALLAS-FORT WORTH RADIOLOGICAL SOCIETY

At the December meeting of the Dallas-Fort Worth Radiological Society, the following officers were elected: President, William H. Neil, M.D., Fort Worth; Vice-President, Helmut A. Mueller, M.D., Dallas; Secretary-Treasurer, Frederick J. Bonte, M.D., 5201 Harry Hines Blvd., Dallas 35, Texas.

MISSISSIPPI RADIOLOGICAL SOCIETY

Newly elected officers of the Mississippi Radiological Society are: President, A. Wayne Sullivan, Jr., M.D., Meridian; Vice-President, B. T. Hickman, M.D., Jackson; Secretary-Treasurer, Jack K. Goodrich, M.D., Department of Radiology, University of Mississippi Medical Center, Jackson.

ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUEBEC

The Association of Radiologists of the Province of Quebec recently elected to its executive board the following officers, all of Montreal: Jean Bouchard, M.D., President; J. S. Dunbar, M.D., Vice-President; O. Raymond, M.D., Hôspital du Sacré-Coeur, Montreal, Secretary; L. I. Vallée, Treasurer. Other directors are: R. L. Duberger, M.D., Sherbrooke; R. G. Fraser, M.D., Montreal; H. Lapointe, M.D., Quebec; M. Samson, M.D., Quebec; I. Sedlezky, M.D., Montreal.

The meeting's secretary is Romeo Ethier, M.D., Montreal Neurological Institute, Montreal, Que.

POSTGRADUATE COURSE DISEASES OF THE CHEST UNIVERSITY OF WISCONSIN

The Departments of Radiology and Pathology of the University of Wisconsin Medical School are sponsoring a Postgraduate Course on Diseases of the Chest, May 11–13, 1961, inclusive. The course will consist of lectures and panel discussions covering a variety of diseases of the lungs and heart. It will be given by a panel of guest speakers, both pathologists and radiologists, together with members of the University of Wisconsin Medical School Faculty. Guest speakers include Drs. John A. Campbell, Benjamin Castleman, Jesse E. Edwards, C. A. Good, Averill A. Liebow, and Eugene Van Epps. Further information may be obtained from William D. Stovall, M.D., Coordinator of Postgraduate Medical Education, University of Wisconsin Medical School, Madison 6, Wisc.

NEURORADIOLOGY COURSE COLUMBIA UNIVERSITY, NEW YORK

The College of Physicians and Surgeons, Columbia University, is offering the Third Annual Postgraduate Course in Neuroradiology, March 27–31, 1961, at the Columbia-Presbyterian Medical Center, New York. Under the direction of Juan M. Taveras, M.D., this course is designed for radiologists, neurologists, and neurosurgeons. The fee is $100.00. Application forms may be obtained from Melvin D. Yahr, M.D., 630 West 168th Street, New York 32, N. Y.

SECOND CONFERENCE ON MICRODOSIMETRY

The Second Conference on Microdosimetry will be held at the Rochester, N. Y., Museum of Arts and Sciences, Feb. 14–15, 1961. The theme of the discussions will center around microdosimeter systems and speakers will include scientists from Brookhaven and Oak Ridge.

The Conference is jointly sponsored by the Rochester Museum, the University of Rochester, and Bausch & Lomb, Inc. Those interested in attending may obtain further information from the Conference Chairman, Dr. Norbert Kreidl, Bausch & Lomb, Inc., Rochester 2, N. Y.

FIFTH INTERNATIONAL CONGRESS OF ELECTROENCEPHALOGRAPHY AND CLINICAL NEUROPHYSIOLOGY

The Fifth International Congress of Electroencephalography and Clinical Neurophysiology will be held at Rome, Sept. 7–13, 1961, in association with the Seventh International Congress of Neurology, Sept. 10–15. Further information may be obtained from the President of the Congress, Prof. Mario Gozzano, or from the Secretary General, Dr. Raffaello Vizioli, Viale Università 30, Rome, Italy.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be

published in the interest of our readers and as space permits.

DIAGNOSTIC ROENTGENOLOGY OF THE DIGESTIVE TRACT WITHOUT CONTRAST MEDIA: A MOUNT SINAI HOSPITAL MONOGRAPH. By BERNARD S. WOLF, M.D., Director, Department of Radiology, The Mount Sinai Hospital, New York; Associate Clinical Professor of Radiology, Columbia University, MANSHO T. KHILNANI, M.B., Associate Fellow in Radiology, The Mount Sinai Hospital, New York, and ARTHUR LAUTKIN, M.D., Associate Radiologist, The Mount Sinai Hospital, New York; Associate Radiologist, Flower & Fifth Avenue Hospitals; Associate Clinical Professor, New York Medical College. A volume of 180 pages, with 245 figures. Published by Grune & Stratton, New York 16, N. Y., 1960. Price $8.75.

CONGENITAL MALFORMATIONS OF THE HEART. VOLUME I: GENERAL CONSIDERATIONS. VOLUME II: SPECIFIC MALFORMATIONS. By HELEN B. TAUSSIG, M.D., Professor of Pediatrics, Johns Hopkins University School of Medicine; Physician-in-Charge, Cardiac Clinic, Harriet Lane Home, Johns Hopkins Hospital, Baltimore, Md. Vol. I: 204 pages; Vol. II: 1,050 pages, both with numerous figures. Published for the Commonwealth Fund by Harvard University Press, Cambridge, Mass., 1960, 2d ed. Price $4.75. (Vol. I); $17.50 (Vol. II).

THE YEAR BOOK OF RADIOLOGY (1960–1961 YEAR BOOK SERIES). RADIOLOGIC DIAGNOSIS. Edited by JOHN FLOYD HOLT, M.D., Professor, Department of Radiology, University of Michigan, and WALTER M. WHITEHOUSE, M.D., Associate Professor, Department of Radiology, University of Michigan. RADIATION THERAPY. Edited by HAROLD W. JACOX, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York, N. Y., and MORTON M. KLIGERMAN, M.D., Professor of Radiology and Chairman of the Department of Radiology, Yale University School of Medicine; Director of Radiology, Grace-New Haven Community Hospital, New Haven, Conn. A volume of 442 pages, with 305 figures. Published by The Year Book Publishers, Inc., Chicago 11, Ill., 1960. Price $11.00.

ANNUAL REVIEW OF NUCLEAR SCIENCE. VOLUME 10. Editor: EMILIO SEGRÈ, University of California. Associate Editors: GERHART FRIEDLANDER, Brookhaven National Laboratory, and WALTER E. MEYERHOF, Stanford University. A volume of 618 pages, with figures and tables. Published by Annual Reviews, Inc., Palo Alto, Calif., 1960. Price $7.00 (U. S. A.); $7.50 elsewhere.

RADIOISOTOPE MEASUREMENT IN NUCLEAR MEDICINE. By FRANK H. LOW, Nuclear Division, Picker X-Ray Corp. A monograph of 68 pages, with numerous figures. Published by Picker X-Ray Corporation, 75 Varick St., New York, 1960. Price $2.50.

BACKGROUND MATERIAL FOR THE DEVELOPMENT OF RADIATION PROTECTION STANDARDS. Staff Report No. 1, May 13, 1960, of the Federal Radiation Council. A pamphlet of 40 pages. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1960. Price 30 cents.

STRAHLENSCHUTZ IN KLINIK UND ÄRZTLICHER PRAXIS. By Prof. Dr. med. WERNER LORENZ, Oberarzt am Röntgen- und Strahleninstitut der Johannes Gutenberg-Universität Mainz. Ergänzungsband 88, Fortschr. a. d. Geb. d. Röntgenstrahlen. A volume of 260 pages, with 62 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1961. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 66.—($15.70); to subscribers to the Fortschritte, DM 59.42—($14.15).

TECHNIK DER RÖNTGENDIAGNOSTIK. By Priv.-Doz. Dr. HANNO POPPE, Leiter des Röntgeninstituts der Chirurg. Univ.-Klinik Göttingen, Oberarzt der Klinik, in collaboration with ILSE LOHSTÖTER, 1. Med.-techn. Assistentin des Röntgeninstituts der Chirug. Univ.-Klinik Göttingen, and Dr. PH. LAUWERS, Direktor der Abt. für Röntgen und wissenschaftliche Anwendungen, Gevaert Photo-Producten N.V., Mortsel (Antwerp), Belgium. A volume of 684 pages, with 939 illustrations on 328 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1961. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 88.—($20.95).

Book Reviews

THE NORMAL SKULL: A ROENTGEN STUDY. By ROBERT SHAPIRO, M.D., Chairman, Department of Radiology, The Hospital of Saint Raphael, New Haven; Associate Clinical Professor of Radiology, Yale University School of Medicine; and ARNOLD H. JANZEN, M.D., Assistant Radiologist, The Hartford Hospital, Hartford; Former Chairman, Department of Radiology, The Grace-New Haven Community Hospital and Yale University School of Medicine, New Haven. A volume of 258 pages, with 645 illustrations on 277 figures. Published by Paul B. Hoeber, Inc., New York 16, N.Y., 1960. Price $18.00.

According to the authors, this book represents an attempt to provide a source of information regarding the normal anatomy of the skull and its wide range

of variability. The earlier chapters deal with technic, embryology, and the general aspects of the childhood and adult skull, following which there are discussions of the foramina, fissures and canals, the vascular supply to the skull and intracranial structures, the sella turcica, the sutures, cranial mensuration, and physiologic calcification. A chapter is devoted to the paranasal sinuses, and one to the ear, mastoid, and petrous pyramid.

The text is not voluminous but is well illustrated with radiographs and many drawings showing the anatomical areas in detail. The work will be of great interest to radiologists, neurosurgeons, students, and technicians.

ROENTGENOLOGIC DIAGNOSIS IN OPHTHALMOLOGY. By EDWARD HARTMANN, M.D., Chief of the Ophthalmic Department, Lariboisière Hospital and American Hospital in Paris, and EVELYN GILLES, M.D., Chief of the Roentgenology Department, Quinze-Vingt Ophthalmic Hospital; Associate in Roentgenology, Saint Antoine Hospital and American Hospital in Paris. Translated by George Z. Carter, M.D., Assistant Professor of Ophthalmology, Albert Einstein College of Medicine. Edited by Conrad Berens, M.D., F.A.C.S., Lecturer on Ophthalmology, New York University Post-Graduate Medical School; Advisory Attending Surgeon, New York Eye and Ear Infirmary; Consultant Emeritus, American Board of Ophthalmology. A volume of 376 pages, with 497 figures. Published by J. B. Lippincott Co., Philadelphia, 1959. Price $15.00.

This work is a translation of a text originally appearing in French under the title *Radiodiagnostic en Ophtalmologie*. It is in general a good book, well written, adequately covering the ophthalmologic aspects of roentgen diagnosis.

Separate chapters are devoted to individual parts of the orbit such as the walls, optic canals, and orbital fissures. Within each chapter radiographic positioning, technic, anatomy, and pathologic conditions are considered. There are excellent chapters on orbital tumors and foreign bodies, as well as separate chapters on fractures, the eyeball itself, and the lacrimal passages.

Extraorbital areas that may be of significance in ophthalmology are also considered, including the paranasal sinuses, petrous apex, sella turcica, the skull in general, and the cervical spine. One chapter briefly describes cerebral angiography and pneumography as related to ophthalmologic conditions. Retrobulbar air studies and orbital phlebography receive attention.

A large number of illustrations are included but, while these are in general adequate, they are frequently poorly labeled. The legends are not always clear, and in several instances explanations on the diagrams appear in the original French. The text also is open to some criticism. The experienced radiologist will find much discussion of radiographic positions, technic, and anatomy, which is better obtained from the older standard works. In addition, there is room for disagreement, in some instances, as to the authors' preferences in these respects. On the other hand, radiographic demonstration of rarely seen ophthalmologic conditions is well presented, and positions and procedures are described which may not be generally familiar.

The book is primarily recommended for the radiologist interested in the more unusual aspects of ophthalmologic radiology, particularly the manifestations of less frequently seen conditions. The ophthalmologist will find in it a full coverage of his specialty in its radiologic aspects.

FUNDAMENTALS OF CHEST ROENTGENOLOGY. By BENJAMIN FELSON, M.D., Professor and Director, Department of Radiology, University of Cincinnati College of Medicine; Director, Departments of Radiology, Cincinnati General, Children's, Daniel Drake, Dunham, Christian R. Holmes, and Longview Hospitals; Special Consultant, U. S. Public Health Service; Consultant to the Dayton and Cincinnati VA Hospitals. A volume of 302 pages, with 450 illustrations on 238 figures. Published by W. B. Saunders Co., Philadelphia, Penna., 1960. Price $10.00.

The author feels that roentgen diagnosis as applied to the chest should be made on the basis of fundamentals rather than from past experiences with similar shadows. His book, therefore, deals mainly with fundamentals and "considers specific entities only insofar as these illustrate or are illustrated by the principles discussed." The first chapter concerns the roentgen work-up, with a brief discussion of the various methods available in the radiological study of the chest, their usefulness, and their shortcomings. The following chapter takes up the localization of intrathoracic lesions, with special attention to the air bronchogram effect and the silhouette sign. The latter sign is very thoroughly discussed both as to its experimental demonstration and its application in the various pulmonary segments.

There are chapters on the lobes, including patterns of collapse; the segmental anatomy and its variations; the diaphragm; the pleura; the extrapleural space; the hilar vessels and lymph nodes. One chapter deals with various miscellaneous signs that have been described, such as the meniscus sign, the notch sign of Rigler, and others. The value and shortcomings of these are clearly recognized. The final chapter is a review of 18,000 normal chest roentgenograms, with observations on the incidence of certain normal variants, such as tracheal deviation, level of the diaphragm, variation in width of the aortic knob, etc.

The author states that the book is intended for cover-to-cover reading. It fulfills this purpose admirably. It is well written, well illustrated, and very readable. It should be of particular value to radiology residents and to any radiologist who wishes an up-to-date review of chest examination.

MODERN TRENDS IN DIAGNOSTIC RADIOLOGY (THIRD SERIES). Edited by J. W. McLAREN, M.A., M.R.C.P., F.F.R., D.M.R.E., Radiologist, X-Ray Department, St. Thomas' Hospital, London; Examiner in Radiology to the Examining Board of England and to Edinburgh University; Sometime Examiner in Radiology, University of London and Faculty of Radiologists. A volume of 286 pages, with 209 figures. Published by Paul B. Hoeber, Inc., New York 16, N. Y., 1960. Price $16.00.

The First Series of *Modern Trends in Diagnostic Radiology*, under the editorship of J. W. McLaren, was published in 1948 (Rev. in Radiology **51:** 588, 1948). A Second Series followed in 1953 (Rev. in Radiology **62:** 432, 1954) and now appears a Third. This offers individual appraisal of recent developments and trends by twenty-four radiologists, each of whom supplies an excellent review of the European and American literature. The single contributor from the United States is in the field of pediatric radiology, F. N. Silverman, M.D., of Cincinnati, Ohio.

The present volume includes three chapters on Apparatus, Protection, and Radiology in Research, respectively, followed by chapters on the chest, a fine section on angiocardiography, with procedure outlines, and three chapters relating to the digestive tract. As in many expanding departments, considerable emphasis is directed to injection technics. There is thus a profound chapter on Cineradiography of the Urinary Tract, as well as discussions of Cerebral Angiography, Percutaneous Selective Renal Arteriography, Lymphangiography, Pelvic Phlebography and Cavography, and Contrast Media.

The bibliography appended to each chapter lists many classical as well as recent pertinent articles. One familiar with all the current literature would find little new information in this text, but the Series is highly recommended for all radiologists. Particular attention is directed to the fine chapter on Pediatric Radiology, and also to the section of Rare Bone Diseases.

DAS RÖNTGENSCHICHTBILD DES OHRES. THE TOMOGRAM OF THE EAR. By Prof. Dr. KARL MÜNDNICH, München, and Dr. KURT-WALTER FREY, München. With an Introduction by Prof. Dr. A. Herrmann and Prof. Dr. H. v. Braunbehrens, München. Ergänzungsband 83, Fortschr. a.d. Geb. d. Röntgenstrahlen. A volume of 126 pages, with 473 illustrations on 205 figures. Published by Georg Thieme, Herdweg 63,(14a) Stuttgart, Germany, 1959. Price DM 66.—($15.70); to subscribers to Fortschritte DM 59.40 ($14.15).

The purpose of this book is to familiarize the otologist and radiologist with the tomography of the ear. By strict adherence to this principle, in that only tomograms and line drawings illustrate the work, the authors have accomplished their purpose and given to the physician a superb atlas. No conventional radiographs appear, nor are they discussed. The approach to the material is mature and subjective: accordingly didacticism is not a feature. Because of this lack of objectivity, some diseases are included and others are not, with no apologies for any omissions.

Sources for the detailed study of the middle and inner ear were dried skulls, postmortem specimens, macerated specimens, plaster models, and living subjects. Tomograms taken both on the autopsy table and in the clinic are reproduced. In accordance with recent German practice, the text is in both German and English in parallel columns.

Twenty brief pages of discussion introduce the material. One hundred pages of illustrations constitute the body of the book. In the division encompassing normal anatomy, the pictures are grouped so that a tomograph, a photograph, a roentgenogram of a bone slide and a line drawing appear as a unit. When the consideration turns toward pathologic changes, the tomogram of the patient is compared with a line drawing. The line drawings are detailed and amazingly accurate. Unfortunately the interpretation is a bit confusing because of the complex letter and number system used for designating the anatomic details.

Because it is in both English and German, the work should find extensive use in this country.

STRAHLENGEFÄHRDUNG UND STRAHLENSCHUTZ IN DER ZAHNÄRZTLICHEN RÖNTGENDIAGNOSTIK. By Professor Dr. med. Dr. med. dent. THEODOR KIRSCH, Oberarzt an der Universitätsklinik und Poliklinik für Mund-, Zahn- und Kieferkranke in Heidelberg. A monograph of 60 pages, with 47 illustrations and 9 tables. Published by Dr. Alfred Hüthig, Heidelberg, Germany, 1960. Price DM 6.80.

Following a short introduction concerning the hazards of ionizing radiation, the author of this book considers in detail the dental use of x-rays with statistical data on different types of dental examination. He describes the instrumentation and gives the results of measurements carried out on patients and at different locations in the x-ray room. Readers may be especially interested in the rules and suggested technical improvements which will result in a lower radiation dose to patient and personnel.

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THE HEAD AND NECK

Appearance of the Ventricular System 24 Hours after Encephalography. A Preliminary Report. Giovanni Ruggiero and Francesco Smaltino. Acta radiol. **53:** 279–283, April 1960. (Hôpital Ste Anne, Paris, France)

The authors emphasize the advantage of a repeat examination of the ventricular system twenty-four hours after pneumoencephalography. Since air is more rapidly resorbed from the subarachnoid space than from the ventricles, on the day following pneumoencephalography there is usually practically no air in the subarachnoid space but still enough in the ventricular system to permit its study. The authors choose to call this "ventriculography without ventricular puncture."

The advantages of studying the air-filled ventricular system without overlying or superimposed air shadows in the subarachnoid space surrounding the brain are obvious. This delayed second examination has been particularly useful in certain cases of astrocytoma, supratentorial tumors which prohibit initial satisfactory air-filling of the ventricular system, and cases of slight or questionable ventricular asymmetry.

Two cases are presented in which the twenty-four-hour examination clarified the findings of the initial pneumoencephalographic study.

It should be pointed out that this report originates in an x-ray department in which pneumoencephalography is routine, even in cases of brain tumor.

Seven roentgenograms.

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Symptomatology and Neuroradiologic Diagnosis of Parasagittal Meningioma. G. Gauthier. Schweiz. med. Wchnschr. **90:** 307–312, March 12, 1960. (In French) (Hôpital cantonal, Geneva, Switzerland)

The author reports 5 cases of parasagittal meningioma. The presence of this tumor can be suspected on the basis of an appropriate clinical examination even before the onset of intracranial hypertension. Clinical data may, however, be inconclusive, in which event resort must be had to auxiliary procedures. In most cases carotid angiography will establish the location and extent of the tumor; in a few this has been supplemented by air encephalography. Operative results depend essentially upon anatomical relations between the meningioma and the superior sagittal sinus. As the latter may be invaded by the malignant growth, early diagnosis is a prerequisite for successful surgery.

Five roentgenograms; 1 drawing; 1 table.

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Bilateral Anomalies of the Middle Cerebral Artery in Recurrent Subarachnoid Haemorrhage. Report of a Case. Olle Höök and Georg-Fredrik Saltzman. Acta radiol. **52:** 347–352, November 1959. (Serafimerlasarettet, Stockholm, Sweden)

Subarachnoid hemorrhage may be due to intracranial vascular anomalies other than arterial and arteriovenous aneurysms. The case is reported of a 47-year-old woman in whom both middle cerebral arteries gave off large lenticulostriate branches, even though the main branches were narrow. In addition to other minor variations, there was a collateral network between the posterior cerebral and pericallosal arteries on the right side. Bilateral carotid arteriograms illustrate the case nicely.

Howard J. Barnhard, M.D.
University of Arkansas Medical Center

A New Device for Skull Radiography. W. Renner. J. Canad. A. Radiologists **11:** 23–25, March 1960. (Hotel Dieu Hospital, Cornwall, Ont., Canada)

A device for standardizing skull radiography has been developed, with which, the author states, even an inexperienced technician can take skull films in half the time normally required. The patient's head rests firmly and comfortably in foam plastic holders, which are designed for the different positions of the skull. Additional features permit a constant focus-film distance, accurate centering, and accurate angulation. The device especially facilitates skull radiography on restless and comatose patients, stereoscopic views, angiograms, and tomograms.

Three photographs.

The Skull in Hyperparathyroid Bone Disease. Kent Ellis and Robert J. Hochstim. Am. J. Roentgenol. **83:** 732–742, April 1960. (Presbyterian Hospital, New York 32, N. Y.)

The classic osseous manifestations of hyperparathyroidism are well known to most radiologists, and the often crucial diagnostic importance of subperiosteal resorption in the phalanges of the hands has been recognized. Not so widely appreciated are the changes in the skull, particularly in the calvarium. The authors review the roentgen findings in the calvarium in 39 patients with primary hyperparathyroidism and bone lesions and report 3 cases in detail. Preoperative skull roentgenograms were not available in 9 cases.

In from one-half to two-thirds of the cases studied, the diagnosis of hyperparathyroid bone disease could be suggested on the basis of the preoperative skull roentgenograms alone. In retrospect, and after comparison with follow-up postoperative films, abnormalities could be detected in all but 2 of the 30 cases. It is emphasized that the distinction between the normal skull and the abnormal skull of hyperparathyroid bone disease is not as apparent as the distinction between the normal and subperiosteally resorbed phalanges in this disease. Nevertheless, in at least 3 of the cases skull roentgenograms clearly indicated the possibility of hyperparathyroidism when the hands were normal. In 1 patient with subperiosteal changes in the hands and in 1 with resorption at the ends of the clavicles, the skull was normal.

The preoperative roentgen findings are classified as follows: *Class 1* (8 cases): Generalized homogeneous, ground-glass type of decrease in density of the calvarium, with loss of sharpness of cortical margins, including the bony walls of vascular channels. *Class 2* (10 cases): Generalized mottled or coarsely granular texture of the calvarium with or without overall loss of density but with loss of sharp cortical margins. *Class 3* (5 eases): Focal patches of decreased density superimposed upon a calvarium of the type of Class 1 or 2, or perhaps very rarely upon an otherwise normal-appearing calvarium. *Class 4* (5 cases): Focal patches of sclerosis in the calvarium superimposed upon any of the

other classes or an otherwise normal-appearing skull.

In discussing the relationship between the bone lesions and serum alkaline phosphatase, it is pointed out that in patients with hyperparathyroidism and with normal or only slightly elevated alkaline phosphatase activity, the characteristic roentgenographic bone changes in the hands or clavicles are usually absent. It is emphasized, however, that when patches of bone sclerosis are demonstrated, particularly in the skull roentgenogram, a normal or only slightly elevated alkaline phosphatase determination does not exclude the possibility of hyperparathyroidism as the cause for these changes.

Postoperative roentgenograms, after surgical cure of the hyperparathyroidism, showed that the appearance of the calvarium had returned to normal in the majority of patients, but in about one-third of the cases in Classes 1, 2, and 3 patches of bone sclerosis had developed coincident with bone repair.

Sclerosis, focal or more general, has long been considered an occasional and expected response of the calvarium to cure of hyperparathyroidism. In the patients with normal or near-normal serum alkaline phosphatase levels who exhibited a persistent or even increased sclerosis of the calvarium following cure of the hyperparathyroidism, the authors believe that the preoperative sclerotic changes represent manifestations of partial or complete healing of the hyperparathyroid bone disease.

The differential diagnosis is discussed.

Twelve roentgenograms; 1 graph; 1 table.

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A Study of the Roentgen Appearance of Cranial Vault Sutures: Correlation with Their Anatomy. John B. Christensen, Ernest Lachman, and Alice M. Brues. Am. J. Roentgenol. **83:** 615–627, April 1960. (University of Oklahoma Medical Center, Oklahoma City 4, Okla.)

Radiologists are concerned with the patency and configuration of the cranial vault sutures for several reasons: The suture may be mistaken for a fracture line. The obliteration of sutures may be pathologically accelerated, as in premature synostosis, or abnormally delayed, as in cretinism or hydrocephalus. The sutures also afford a means of evaluating physiologic maturation throughout life and at ages when most other indicators of skeletal development have lost their usefulness.

To test the reliability of the roentgen evaluation of sutural status, the authors correlated the roentgen appearance of the cranial vault sutures of 26 intact cadaver heads with the results of direct observation on the external and internal aspects of the calvaria of the same heads after removal of all soft tissues. Roentgenograms were taken in the anteroposterior, lateral, and Towne projections.

It was found that if the endocranial suture is at least three-quarters closed, no suture line is seen on the roentgenogram. If the suture is closed endocranially but open ectocranially, all variants are observed, from disappearance of the suture line to complete patency. A suture which is open anatomically on its outer and inner aspects is invariably demonstrated on the roentgenogram, either as an intermittent open line or more commonly as a completely open line.

Interestingly, intermittent or completely open suture lines were frequently visible in skulls in which both ecto- and endocranial surfaces were three-quarters to fully closed. Roentgenographically open suture lines seem to increase in frequency when calvaria with ecto- and endocranially open sutures are compared with crania displaying beginning endocranial fusion.

Roentgenographic "opening-up" of the suture may be explained by (1) bone absorption in the diploë occurring with suture closure of the ecto- and endocranial surface aspects or (2) the plane of the suture assuming a more favorable angle for visibility as the suture begins to close.

Ten figures, including 8 roentgenograms; 3 tables.

MICHAEL LAZOREK, M.D.
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Roentgenologic Manifestations of Fracture of the Orbital Floor (Blow-Out Fracture). J. R. Lewin, D. H. Rhodes, Jr., and E. J. Pavsek. Am. J. Roentgenol. **83:** 628–632, April 1960. (Mercy Hospital, Pittsburgh 19, Penna.)

Depressed fractures of the orbital floor are often overlooked by the radiologist in cases of facial trauma because of a lack of awareness that such fractures may be present even when the orbital rim itself is intact. Fractures of the normally extremely thin floor of the orbit have been referred to as "blow-out or hydraulic fractures." This type of fracture is caused by a sudden increase in intra-orbital pressure when an object hits the front of the orbit and, with or without rupturing the eyeball, forces the orbital contents backward. The thin medial orbital wall may be fractured along with the floor, or the medial wall alone may be fractured. This injury may likewise result from blows of the fist.

Fractures of the orbital floor should be suspected after any blow to the eye which produces a severe ecchymosis of the eyelid. Roentgenographically, the orbital wall is visualized as a slender curvilinear osseous density depressed into the attic of the antrum to varying degrees. Just superior to the displaced osseous fragment or fragments may be seen a soft-tissue density which represents downward prolapse of the edematous inferior orbital contents. Waters and Caldwell views have been regarded as the most valuable for delineating this injury, and laminagraphy has been considered of little value. On the basis of their experience, the authors recommend a selectively modified Waters projection, supplemented by laminagraphy when soft-tissue swelling interferes with visualization of the structures.

Three cases are reported.

Eight roentgenograms.

MICHAEL LAZOREK, M.D.
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Laminagraphy in the Follow-Up of Fractures of the Odontoid Process. Julius Solovay and Gratien B. Brice. Am. J. Roentgenol. **83:** 645–652, April 1960. (VA Hospital, Montgomery, Ala.)

Fracture of the odontoid process generally occurs at its base and may extend into the upper anterior portion of the body of the axis. Routine anteroposterior and lateral roentgenograms of the cervical spine and open-mouth roentgenograms of the odontoid process have often been unsatisfactory in diagnosis and follow-up. The fracture line is frequently difficult to visualize in the open-mouth roentgenogram because of its obliquity from behind forward, and because of its location in cancellous bone. In the lateral roentgenogram, the superimposed structures of the atlas may obscure the fracture. Laminagraphy may be required to confirm

its presence and is the method of choice for follow-up examinations. Routine roentgenography will show a loose fibrous pseudarthrosis, but laminagraphy may be necessary to differentiate bony union from firm fibrous union.

The authors report 10 fractures of the odontoid process. Follow-up studies showed that 4 of these healed by bony union, 3 by firm fibrous union, 2 by loose fibrous pseudarthrosis. One case had not been followed long enough for determination of the result. With bony union, the patient may resume normal activity without danger of late neurologic complications. Firm fibrous union is compatible with safety. With loose fibrous union, a sudden jerk of the head or violent activity may cause luxation of the odontoid process and compression of the spinal cord.

Sixteen roentgenograms; 1 table.

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THE CHEST

Injuries of the Trachea and Major Bronchi. R. Maurice Hood and Herbert E. Sloan. J. Thoracic & Cardiovas. Surg. **38:** 458–477, October 1959. (H. E. S., University of Michigan Medical School, Ann Arbor, Mich.)

Seven cases of injury of the tracheobronchial tree are reported. These are considered with 91 cases recorded in the literature since 1947. Certain facts and principles emerged from this study:

Injuries to the trachea and major bronchi are occurring with increasing frequency. In the majority of cases the injury consists of compression or crushing chest trauma. Symptoms and signs may include subcutaneous emphysema, dyspnea, cyanosis, hemoptysis, pain, shock, and pneumothorax. Pneumothorax, said to be present invariably, was identified in only 55 of 82 cases in which this information was recorded. Tension pneumothorax occurred in only 21 cases. Subcutaneous emphysema was detected in just slightly over half of the patients. Cyanosis was present in 24 patients, pain in 20, hemoptysis in 18, shock in 14, cough in 8, and hemothorax in 4. Early roentgen findings may be those related to pneumothorax but may be negative; late roentgenograms will usually show complete atelectasis.

As far as can be determined, bronchoscopy was instrumental in establishing the exact diagnosis more than any other procedure, *i.e.*, in 54 of 85 patients on whom information was available. Bronchography was used in late cases to demonstrate either bronchial strictures or termination of the bronchial stump and complete disruptions in 16 cases. It was the means of diagnosis in 9 of the 85 cases. Planigraphy was employed occasionally and was listed as leading to the diagnosis in only 1 case. In 16 cases, the diagnosis was made clinically; in these instances the patient's condition was extremely grave and rapid diagnosis and treatment were imperative.

Bronchial lacerations should be suspected from the type of trauma and when tension pneumothorax or subcutaneous emphysema is present. A careful roentgenographic follow-up for at least two weeks will disclose most injuries escaping earlier detection. In only 30 of the 90 cases, in which the information was available, was the diagnosis established in the first twenty-four hours. Eight cases were diagnosed by the end of seven days, and 15 others by the end of one month. In 37 patients the time elapsing before diagnosis was one month to nineteen years.

Immediate primary repairs or anastomosis is the preferred treatment for injuries of the trachea and major bronchi. This is almost always technically feasible. Anastomosis, even if delayed for weeks, months, or years after the injury, is usually successful, and excellent function is obtained. Resection penalizes the patient by the removal of gross amounts of normal lung tissue, which may result in serious respiratory insufficiency.

Eight roentgenograms; 1 photograph; 6 tables.

Unilateral Emphysema. R. F. Fouché, J. R. Spears, and Colin Ogilvie. Brit. M. J. **1:** 1312–1315, April 30, 1960. (London Hospital, London, England)

An apparent increase in the radioluceny of one lung may be due to rotation, to diminished contralateral radiolucency, to giant cysts or bullae, to compensatory emphysema, or to obstructive emphysema resulting from incomplete bronchial occlusion. Macleod (Thorax **9:** 147, 1954) described a group of cases in which none of these causes was apparent. The authors present the radiologic and physiologic features of 7 similar cases, in 5 men and 2 women, aged thirty-eight to seventy.

All the patients in this group gave a long history of recurrent cough and exertional dyspnea, and 6 had pneumonia or pleurisy in early life, 4 of them in childhood. Radiographs showed an increased radiolucency of one lung, with diminished hilar and peripheral vascular shadows on the affected side. The position of the mediastinum at rest was variable, but in every case it deviated toward the affected side on inspiration and away from it on expiration. Bronchography revealed crowding of the right lower lobe bronchi, without apparent obstruction or bronchiectasis, in 2 patients; in a third the pattern was normal, except for poor peripheral filling. Whole-lung tomography demonstrated a decrease in the caliber of the main pulmonary artery and of the peripheral vessels on the affected side, with (except in 1 case) an apparent increase in caliber on the opposite side. The greatest reduction in vessel size was observed in the middle and lower zones in 5 patients, throughout the right lung in 1 patient, and in the upper and middle zones of the left lung in 1. The small pulmonary artery need not necessarily imply congenital maldevelopment, for diminution of the peripheral vascular bed from disease in the lung might result in functional shrinkage of the proximal vessels.

Pulmonary function studies revealed an increase in the residual volume and a decreased maximum breathing capacity. A slight increase in the latter after a bronchodilator drug suggests that there was only a small element of reversible bronchial obstruction. Bronchospirometric studies in 1 patient showed a somewhat reduced contribution to oxygen uptake by the affected lung.

The authors' observations in these cases indicate that temporary bronchial obstruction in childhood, during the course of a respiratory infection, may have damaged the parenchyma, resulting in later life in overexpansion and impaired deflation because of loss of elastic recoil in expiration. In the cases showing bronchial crowding, there may be a "compensatory" emphysema of the parts not subjected to obstruction.

Four figures, including 2 roentgenograms; 3 tables.

GARTH R. DREWRY, M.D.
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A New Form of Respiratory Disease in Premature Infants. Miriam G. Wilson and Victor G. Mikity. J. Dis. Child. **99:** 489–499, April 1960. (University of California Hospital, Los Angeles 24, Calif.)

Since 1956, the authors have seen 5 premature infants with a respiratory disease of unknown etiology. These cases are reported in detail. In no instance was the process a continuation of the commonly seen neonatal respiratory infections or atelectasis.

At one to five weeks of age, respiratory symptoms developed insidiously. Usually intermittent cyanosis and hyperpnea were first noted. The cyanosis became generalized; hyperpnea increased; dyspnea, especially on effort, appeared. Overexpansion of the chest, wheezing, and cough were observed as the disease progressed. No râles were audible unless heart failure intervened, nor was fever present unless infection occurred. Late in the course of the disease there was a strong tendency to the development of cor pulmonale. The effect on general growth was variable. Three of the 5 infants died, of cardiac failure, respiratory failure, and enterocolitis, respectively.

A consistent and striking roentgen finding was bilateral, coarse, streaked pulmonary infiltration with small areas of emphysema, occasionally appearing cystic. Extensive lung involvement was always apparent in the initial chest film and in 1 infant preceded abnormal respiratory symptoms by ten days. In the 2 infants who survived, the pulmonary infiltration gradually cleared, although a moderately severe basal emphysema tended to persist.

Electrocardiography characteristically showed progressive right ventricular hypertrophy. Repeated attempts to demonstrate bacteria, viruses, fungi, or parasites were unsuccessful. No evidence of pancreatic fibrocystic disease was found.

Histologic examination of lung tissue obtained at biopsy or postmortem revealed in all cases a prominent emphysema with fibrosis and interstitial mononuclear cellular infiltration. Clinically the disease under discussion resembles closely so-called interstitial plasma-cell pneumonia, but histologic studies unequivocally differentiate the two. The histologic appearance of the lungs closely resembles that seen in the Hamman-Rich syndrome, but to date that disease has been reported only in adults and never in the neonatal period.

Since the original report, 2 additional premature infants with this condition have been seen. A similar clinical picture has not appeared in any of the full-term infants born at the Los Angeles County Hospital.

Eight roentgenograms; 3 photomicrographs; 1 table.

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Current Concepts of Pneumoconioses—Clinical Aspects. O. A. Sander. J.A.M.A. **172:** 1587–1590, April 9, 1960. (710 N. Plankinton Ave., Milwaukee, Wisc.)

Pulmonary Function Impairment in Pneumoconioses. Hurley L. Motley. J.A.M.A. **172:** 1591–1595, April 9, 1960. (1212 Shatto St., Los Angeles 17, Calif.)

Sander warns against the misdiagnosis of pneumoconiosis on the basis of an incomplete investigation. The triad of diagnostic criteria must be scrupulously applied in every case, namely (1) the medical history, (2) roentgenographic pattern, and (3) physical, physiological, and laboratory findings. A case is reported in which a misdiagnosis of silicosis was made from the roentgen findings and an incomplete occupational history.

While some dusts such as crystalline-free silica and asbestos cause a fibrous reaction in the lungs, others are quite inert when retained in minimal to moderate concentrations. Iron dust can be retained in focal areas in the lungs in sufficient amount to be visualized on the roentgenogram as nodulation but produces no fibrosis. An illustrative case is reported. The author stresses the importance of information on the exact environmental factors before arriving at a diagnosis and points out that such information is at times available from industrial hygiene surveys.

The smoking habits of the patient are important. The literature is quoted to indicate that there is a correlation between excessive smoking and impairment of the ventilatory capacity of the lung and that smoking may be a major factor in the development of bronchitis, bronchiolitis, and obstructive emphysema.

The roentgen features of the pneumoconioses are not specifically discussed.

A more realistic approach to the problem of pneumoconiosis is urged. The patient who has symptoms or thinks he has symptoms deserves the same consideration as any other patient. It should not merely be determined whether or not he has an occupational disease for which he may receive compensation. Concern over this point should not divert attention from the equally important problem of rehabilitation.

Five roentgenograms.

Motley's article is concerned with the impairment of pulmonary function in pneumoconiosis. The major physical changes consist of impairment in alveolar aeration, hypoxia and hypercapnia from disturbances in the transport of oxygen and carbon dioxide in the lung, and decreased pulmonary blood flow during exercise from lack of expansibility of the pulmonary vascular bed. Emphysema and fibrosis occur in varying degrees in patients with pneumoconiosis. To determine the extent of pulmonary function impairment adequate tests are required to evaluate (1) the ventilatory status, (2) the transport of oxygen and carbon dioxide in the lung, and (3) the pulmonary blood flow. The results of pulmonary function measurements in 3 men with severe functional impairment are given in detail.

A roentgenographic and pulmonary function study was performed in 98 diatomite workers. There was an overall lack of correlation between the degree of pulmonary function impairment and the roentgen findings.

It is concluded that positive roentgenographic findings alone, timed vital capacity alone, or any other single function test is not sufficient reason for removing a worker from his job. Accurate testing of pulmonary function should be done more extensively, and serial follow-up studies are necessary in handling the individual case.

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Farmer's Lung. Report of Two Cases. William P. Baldus and James B. Peter. New England J. Med. **262:** 700–705, April 7, 1960. (University of Minnesota Medical School, Minneapolis 14, Minn.)

Farmer's lung is a clinical entity in which the development of respiratory symptoms follows the inhalation of dust from moldy hay, silage, or grain. It seems likely that a fungus is the cause of the disease. Some believe that the pathogenesis involves a primarily mechanical process in which there is either a pulmonary-tissue

reaction to dust particles or an actual blocking of terminal bronchioles by fungal spores or their breakdown products. Others think that a hypersensitivity reaction to molds or their products of disintegration may be the main factor.

The disease attacks farmers who have been working in the dust of moldy hay, silage, or grain. Dyspnea is the chief symptom in almost all cases and may be accompanied by fever, chills, nonproductive cough, malaise, and weight loss. The presence of diffuse crepitant râles is often the only physical finding. Occasionally *Candida albicans* has been cultured from the sputum. The clinical course is variable and depends on the intensity and frequency of exposure as well as patient sensitivity. The acute attack is manifested by the rapid onset of symptoms that subside after a few days, often without the patient having been seen by a physician. The subacute phase is characterized by progressive dyspnea and cough resulting from repeated exposure to mold dust over a period of months. The chronic phase occurs after repeated exposure over a period of years. The patient is left incapacitated with irreversible emphysema and pulmonary fibrosis.

Farmer's lung and silo-filler's disease are distinct entities. Silo-filler's disease is caused by inhalation of nitrogen dioxide gas when one enters a recently filled silo. The clinical course of this illness is very acute, and the outcome is frequently fatal.

The pulmonary x-ray changes in farmer's lung are nonspecific. Fine, nodular densities are scattered diffusely throughout both lung fields, but are more prominent in the central portion, producing a picture that has been described by the terms "sandstorm" and "miliary" (Frank: Am. J. Roentgenol. **79:** 189, 1958. Abst. in Radiology **71:** 890, 1958). In addition, a fine reticular pattern may be superimposed, resulting in a reticulonodular appearance. Although the x-ray findings may be minimal at the onset of symptoms, they usually parallel the severity of the symptoms. After the acute episode subsides, the roentgen changes gradually clear. Repeated exposure, however, results in increasing emphysema and fibrosis.

Two cases of farmer's lung are reported. In 1 patient, an exacerbation of symptoms followed a test inhalation of the dust of the suspected moldy hay. Pulmonary biopsy was performed in both instances. Findings were similar to those described elsewhere—focal, noncaseating granulomas surrounded by giant cells and accompanied by an interstitial infiltration of histiocytes and lymphocytes. The granulomas are usually peribronchiolar in distribution.

Four roentgenograms; 2 photomicrographs.

MORTIMER R. CAMIEL, M.D.
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Periarteritis Nodosa with Labile and Recurrent Pleuropulmonary Manifestations Without Asthma or Serum Hypereosinophilia. J. Turiaf, P. Marland, and Mme. G. Basset. J. franç. de méd. et chir. thorac. **14:** 175–184, 1960. (In French) (Paris, France)

Pulmonary involvement in periarteritis nodosa may occur in almost any stage of the disease. It may be present at the onset. At other times the pulmonary manifestations are among many involving several organ systems as the disease progresses or undergoes exacerbation. The lung changes may go through a chronic sort of evolution or remissions may be followed by rather explosive recurrences. Furthermore, pulmonary involvement apparently does not affect the prognosis as vitally as do lesions of the cardiovascular, renal, and nervous systems.

Periarteritis assumes three principal aspects in the lungs. One of these is an asthmatic state with fleeting infiltrates and eosinophilia. Acute and chronic forms of pneumonitis may appear, with fever and perhaps dyspnea and hemoptysis. Several types of radiographic picture may be seen. There may be accentuation and opacification of the bronchovascular arborizations. In some cases, multiple miliary nodules are present. In others reticulonodular lesions are demonstrable, especially in the hilar and basal regions. Another type of picture consists of multiple ill-defined or cotton-like opacities resembling snowflakes. Exceptionally, a cavity is present. Sometimes round pseudotumoral shadows may be noted in one or both lungs.

A case is reported in which the patient may have had a pulmonary type of onset, although this could not be proved definitely. During the course of the disease there were three exacerbations of pulmonary involvement, unaccompanied by eosinophilia. The lung lesions responded to steroid therapy. The patient died about nine months after admission, following an intestinal hemorrhage. Autopsy revealed an extensive mesenteric infarct. Histologic study showed typical lesions in the skin, lung, pancreas, testicle, and mesentery.

Six roentgenograms; 3 photomicrographs.

CHARLES M. NICE, JR., M.D., PH.D.
Tulane University

Chronic Active Pulmonary Histoplasmosis with Cavitation. A Clinical and Laboratory Study of Thirteen Cases. David F. Loewen, John J. Procknow, and Clayton G. Loosli. Am. J. Med. **28:** 252–280, February 1960. (Macon County Tuberculosis Sanatorium, Decatur, Ill.)

The clinical and laboratory findings in 13 cases of chronic active pulmonary histoplasmosis are presented. All 13 patients (12 men, 1 woman) were white; the age range was from forty-seven through seventy-five years. All but 1 were thought initially to have pulmonary tuberculosis and were treated for that disease in a sanitarium for varying periods of time. Seven patients were brought to medical attention through mass surveys. Chest roentgenograms revealed varying degrees of unilateral or bilateral pulmonary infiltration and cavitation which simulated tuberculosis. Hilar and/or peripheral calcifications were noted in all cases. Clinical manifestations were indistinguishable from those of tuberculosis. All 13 patients reacted positively to the histoplasmin skin test, and sputum examinations were repeatedly positive for *H. capsulatum*.

Treatment of chronic pulmonary histoplasmosis in selected cases, as in tuberculosis, can be successfully carried out by surgical resection of the lesions. Drugs, with the exception of Amphotericin B, have not proved effective in patients with bilateral cavitation. Three of the authors' 13 patients died; 5 were apparently cured at the time of this report and another was asymptomatic, with some clearing of the pulmonary lesion; 2 patients were clinically well but the disease process in the lungs was still active; 1 patient had shown marked progressive extension of the lesions associated with massive hemoptysis and expectoration of profuse quantities of sputum; 1 had a unilateral lesion which was considered suitable for resection, but he refused surgery.

These 13 cases of chronic cavitary histoplasmosis closely resemble 73 previously recorded in the literature. The age range of the patients emphasizes the fact that this is an adult form of histoplasmosis. Seventy-three of 83 patients tested gave a positive skin test with histoplasmin. Only 42 of 79 tested were tuberculin-positive. Thirty-eight had positive skin tests to both histoplasmin and tuberculin antigens. More recent cases are mentioned in an addendum.

In areas of high endemicity, physicians and health workers should be alerted to the fact that many cases of histoplasmosis may be found in tuberculosis sanatoriums.

Thirty-eight roentgenograms; 1 photograph; 5 photomicrographs; 11 tables.

Asymptomatic Pulmonary Alveolar Proteinosis. William E. Furst, Bertrand M. Bell, and George V. Irons, Jr. Am. J. Med. **28:** 453–457, March 1960. (W. E. F., Department of Radiology, University of Chicago, Chicago 37, Ill.)

Pulmonary alveolar proteinosis is a chronic pulmonary disease of unknown etiology characterized histopathologically by the intra-alveolar deposition of a proteinaceous periodic acid-Schiff positive substance, which is high in lipid content. The condition was first described by Rosen, Castleman, and Liebow (New England J. Med. **258:** 1123, 1958. Abst. in Radiology **72:** 608, 1959).

The clinical picture in this entity is nonspecific. Progressive dyspnea and cough, which was usually productive, were the chief presenting symptoms in Rosen's cases. Physical findings were remarkable by their absence. Radiographically "there is a fine, diffuse, perihilar, radiating, feathery or vaguely nodular, soft density, resembling in its butterfly distribution the pattern seen in severe pulmonary edema." The key to this radiologic picture is the absence of clinical findings which would suggest pulmonary edema. Sarcoidosis can be distinguished by the hilar adenopathy.

Furst, Bell, and Irons report a case of pulmonary alveolar proteinosis which is unusual in certain respects. Their patient, a 34-year-old man, was completely asymptomatic. If a roentgenogram of the chest had not been taken as part of a routine physical examination, the disease, for the time being, would not have been detected. Corroborative data including representative radiographs and photomicrographs of the biopsy specimen of the lung are presented. This case offers a unique opportunity to follow the natural history of this condition and to observe the effect of various therapeutic programs on its course.

Three roentgenograms; 3 photomicrographs.

Pulmonary Alveolar Proteinosis. A Correlation of Pathological and Physiological Findings in a Patient Followed Up with Serial Biopsies of the Lung. William Fraimow, Richard T. Cathcart, J. J. Kirshner, and Richard C. Taylor. Am. J. Med. **28:** 458–467, March 1960. (Jefferson Medical College, Philadelphia, Penna.)

In 1958, Rosen *et al.* (see preceding abstract) reported 27 cases of a new pulmonary disease entity which they called "pulmonary alveolar proteinosis." One of the patients in this series has now been followed for over thirty-two months, with multiple biopsies of the lung and serial studies of pulmonary function. The authors present the findings in this case.

The patient was a previously healthy young white man who experienced gradually increasing dyspnea, at first on exertion but eventually even at rest, fatigue, anorexia, marked weight loss, and finally cyanosis. At this point a remitting type of temperature curve developed, with evening elevations to 101° F., and the patient was admitted to a sanatorium for treatment of suspected tuberculosis. Vigorous search for tubercle bacilli failed to disclose any organisms. The picture was somewhat complicated by a history of exposure to silica dust for two and a half months some four to five months prior to the onset of symptoms. At the peak of his illness, the patient exhibited marked pulmonary insufficiency due both to alveolar-capillary block and increased venous admixture.

During the follow-up period, the pathological, physiological, and roentgenographic findings showed a marked improvement. This was accompanied by a progressive improvement in the clinical status to the point that the patient became symptom-free. The ultimate prognosis must remain guarded, however, because of the obscure etiology of the disease and the present lack of knowledge as to its course.

Three roentgenograms; 5 photomicrographs; 2 tables.

Multiple Myeloma Manifested as a Problem in the Diagnosis of Pulmonary Disease. Edward A. Favis, Herbert D. Kerman, and William Schildecker. Am. J. Med. **28:** 323–327, February 1960. (H. D. K., Halifax District Hospital, Daytona Beach, Fla.)

Pulmonary involvement in multiple myeloma is uncommon. In one series of 57 cases, there were no symptoms or physical findings referable to the respiratory tract (Kenny and Moloney: Ann. Int. Med. **46:** 1079, 1957. Abst. in Radiology **70:** 621, 1958).

The authors report a case of multiple myeloma in which extraosseous pleuropulmonary manifestations were dominant. The patient was a 60-year-old woman who complained of weakness, anorexia, dyspnea, and pain in the left lower chest anteriorly. Roentgen examination disclosed a rounded soft-tissue density, measuring approximately 5 cm. in its greatest diameter, in the lateral aspect of the right mid-lung. This was adjacent to and contiguous with the pleura and suggested loculated pleural fluid. A larger area of homogeneous density obscured the entire left lower field and was associated with fluid in the left pleural space. In addition, there was a similar shadow in the superior medial aspect of the right upper lung field, which also suggested encapsulated fluid. Spot-films for bony detail over the areas of density failed to demonstrate any definitive areas of bone destruction, demineralization, or other osseous abnormality in these zones. Multiple myeloma was first suspected in this case when excessive rouleaux formation was discovered in a peripheral blood smear. Further confirmatory evidence was the typical electrophoretic pattern of the serum proteins. Roentgenograms of the left scapula, right femur, ischium, and skull showed the classical picture of multiple myeloma. The presence of numerous plasma cells in the pleural fluid and bone marrow established the diagnosis. The authors believe that the lesion in the right lung is probably a pleural plasmacytoma and that the area in the left lung is a subpleural and pulmonary parenchymatous plasmacytoma.

X-ray therapy delivered to the right mid-lung and left lower lung produced a rather striking regression of

the areas of pulmonary infiltration and pleuropulmonary involvement. Despite this, the patient continued to complain of considerable discomfort in the left lower chest with anorexia, weakness, and weight loss. The administration of urethane and Triamcinolone brought about a definite improvement in her condition.

Two roentgenograms; 2 photomicrographs; 1 graph.

Primary Pleural Cancers. An Attempt at Classification of Primary Pleural Tumors. R. Even and Ch. Sors. J. franç. de méd. et chir. thorac. **14:** 143–157, 1960. (In French) (Paris, France)

Certain criteria are necessary in order to give autonomy to the primary pleural mesotheliomas. The clinical criteria are centered on the large area of thickened pleura with pleuritis and possible serous effusion in one or two other cavities such as the pericardium and peritoneum.

Histologically three principal types of tumor are noted. One is an adenoid type; another, called endoepithelial, has some gland-like spaces; the third, designated "conjunctive," resembles a fibroplastic sarcoma.

The so-called macroscopic criteria are based on the rather exclusive involvement of the celomic cavities, in the absence of visceral metastasis except for invasion of the mediastinal or peritoneal lymph nodes.

Seven figures, including 1 roentgenogram.

CHARLES M. NICE, JR., M.D., PH.D.
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A Preliminary Study of the Lengths of the Two Main Bronchi and Angle at the Carina. G. A. Kher and J. S. Makhani. J. Indian M. A. **34:** 262–265, April 1, 1960. (Department of Anatomy, Mahatma Gandhi Memorial Medical College, Indore, India)

Measurements were made of the lengths of the two main bronchi and of the angle at the carina on 53 bronchograms and on cadaver specimens from 54 adults and 36 fetuses. The technic is described and the results are given as follows:

	Range	Average
Angle between 2 main bronchi	30–105°	60.6°
Length of upper part of right main bronchus		
Bronchographic study	0.0–3.5 cm.	1.67 cm.
Dissected lungs	1.0–2.7 cm.	1.81 cm.
Length of upper part of left main bronchus		
Bronchographic study	1.5–5.2 cm.	3.2 cm.
Dissected adult lungs	2.3–6.0 cm.	4.0 cm.
Dissected fetal lungs	0.9–2.7 cm.	1.44 cm.

One diagram; 3 graphs; 9 tables.

THE HEART AND BLOOD VESSELS

Right Atrial Myxoma. Diagnosis During Life; Successful Surgical Removal. Hyman Ashman, Lawrence I. Zaroff, and Ivan Baronofsky. Am. J. Med. **28:** 487–496, March 1960. (Mt. Sinai Hospital, New York 29, N.Y.)

The most important aspect of the diagnosis of atrial myxoma during life seems to be an awareness of the possibility of a benign tumor of the heart. Once suspected, the diagnosis is relatively easy to prove or disprove. The authors report a case of right atrial myxoma, which was diagnosed clinically, proved by angiocardiography, and successfully removed by open heart surgery.

Van Buchem *et al.* (Dis. of Chest **31:** 61, 1957. Abst. in Radiology **69:** 765, 1957), in a study of a case of left atrial myxoma, found that "strikingly powerful pulsations of the esophagus may occur synchronously with ventricular contractions at the level of the atrium." This was demonstrated by fluoroscopy and recorded by kymography. To produce this sign the tumor would have to be of considerable size and of firm consistency. This phenomenon is absent in enlargement of the left atrium due to mitral stenosis. Two other roentgen findings may contribute to the differential diagnosis of primary intracavitary tumors of the heart. First, in cases clinically suggestive of mitral stenosis, the degree of dyspnea is strikingly disproportionate to the left atrial enlargement. Second, in cases of right atrial myxoma, clinically suggestive of tricuspid stenosis, the lungs are remarkably free of vascular engorgement even with advanced evidence of right heart failure. Otherwise the roentgen findings are not distinctive. The heart may be of normal size and configuration, despite severe symptoms, or various chamber enlargements and straightening of the left border of the heart, consistent with right or left heart failure, may be present. Congestive changes will appear in the lungs if left heart failure exists. Electrocardiographic changes are not specific, and cardiac catheterization is not of definitive value in the diagnosis of primary intracavitary tumor of the heart. Short of surgical exploration, angiocardiography is the most reliable means of establishing the diagnosis. Furthermore, it reveals the size and location of the tumor and may yield clues to the site of its attachment to the atrial wall.

All attempts to remove intracardiac tumors by closed methods have resulted in failure. With the great improvement of open methods, over the past few years, these benign intracardiac tumors can be easily and safely removed.

Seven figures, including 1 roentgenogram; 1 table.

Familial Muscular Subaortic Stenosis. An Unrecognized Form of "Idiopathic Heart Disease," with Clinical and Autopsy Observations. Lawrence B. Brent, Akio Aburano, Don L. Fisher, Thomas J. Moran, Jack D. Myers, and W. Jape Taylor. Circulation **21:** 167–180, February 1960. (University of Pittsburgh School of Medicine, Pittsburgh, Penna.)

Subaortic stenosis has been regarded as a rare condition, usually caused by an easily demonstrable fibrous ridge attached to the left ventricular myocardium below the aortic valve. The authors' experience has suggested to them the occurrence of another form, with a familial incidence, characterized by muscular hypertrophy of the left ventricular outflow tract. Twelve cases in two families, each represented by three generations, are reported.

Roentgenography (plain films) and fluoroscopy, in the cases in which they were employed, suggested left ventricular enlargement. Angiocardiography was not done. Pressure recordings showed a systolic pressure gradient across the aortic valve area. One patient was operated upon for supposed valvular stenosis, but the lesion was not appreciated until autopsy. No surgery is feasible at present for this condition.

Clinically these cases seem to resemble aortic stenosis of any origin, with syncope and sudden death at any age as prominent manifestations. The distinguishing

features are the apical and lower left sternal border location of the systolic murmur, the absence of posterior dilatation of the ascending aorta, absence of calcification of the aortic valve, absence of a murmur of aortic insufficiency, and the familial occurrence.

Thirteen figures, including 4 roentgenograms; 1 table.

ZAC F. ENDRESS, M.D.
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Roentgenographic Demonstration of the Coronary Arteries. Gunnar Jönsson and Lars Hellström. Acta radiol. **53:** 273–278, April 1960. (Roentgen Department I, Södersjukhuset, Stockholm, Sweden)

Coronary artery demonstration was evaluated by a review of the 63 thoracic aortographic examinations performed at the Södersjukhuset (Stockholm) during the past five years. Thirty-seven of the patients had coarctation of the aorta; in these, biplane studies were done with three pairs of films per second. Most of the other 26 patients had aortic valvular disease, and six pairs of films per second were exposed. In general, an attempt was made to place the tip of the catheter in the middle portion of the ascending aorta, and 20 to 30 ml. of contrast medium per second was injected mechanically.

In 6 cases the coronary vessels were visible for only a few centimeters peripheral to their origin in the aorta; in 10, the proximal half of the arteries was visible; in the remaining 47 cases they were clearly demonstrated out to their furthermost peripheral branches. Both coronary arteries were filled in all cases and, in general, the filling on the right and left sides was comparable. In the 3 instances where the filling did appear different in the two arteries (and no anomaly or pathologic lesion could be demonstrated), the flow of contrast medium from the catheter had been eccentric in the aorta and directed toward one side. In all cases in which a high concentration of contrast medium was obtained in the aortic bulb, the coronary arteries were distinctly visualized in their entirety.

Toward the end of the investigation period, after side-hole catheters became available, the catheter tip was placed directly above the points of origin of the coronary arteries; clear demonstration of both arteries was achieved in all cases examined with this technic.

The method of aortography currently employed by the authors is as follows: The patient is examined in the supine position with the left side slightly raised. Intrathoracic pressure is elevated by 20 to 30 mm. Hg in order to reduce the minute volume of the heart. A side-hole catheter with as wide a lumen as possible is used. The catheter tip is positioned immediately above the opening of the coronary vessels, contrast medium is injected rapidly with a mechanical injector, and a rapid succession of exposures is made.

In the authors' opinion, completely satisfactory visualization of both coronary arteries can be obtained with this technic, thus obviating the necessity of more complicated and hazardous procedures.

Seven roentgenograms.

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Arteriographic Findings in Coronary Sclerosis. L. di Guglielmo. Acta radiol. **52:** 369–378, November 1959. (Istituto di radiologia medica dell'Università di Pavia, Italy)

From 274 cases in which thoracic aortography had been performed to visualize the coronary vessels, the author selected 96 which showed particularly good filling and thus lent themselves well to morphologic investigation. The age of the patients ranged from seven to sixty-nine years.

In comparison with the pre-twenty-year group, distinct changes may be seen beginning in the next two decades and increasing thereafter. The arteriographic signs of coronary arteriosclerosis include:

1. "Sinuosities."
2. A relative decrease in diameter of the arteries in comparison with the volume of the heart and an increase in the spacing of the vessels.
3. Tortuosity, with a corresponding increase in the length of the artery.
4. A cylindrical shape of the coronary branches rather than a gradual tapering off; sharply constricted sections distal to the points where branching takes place.
5. Gaps and small filling defects in the arteries, probably caused by atheromatous protrusions.

Interestingly, the signs of coronary sclerosis were found most frequently in patients with coarctation of the aorta.

Seven roentgenograms, with accompanying diagrams; 1 table.

HOWARD J. BARNHARD, M.D.
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Coronary Arteriovenous Fistula into Main Pulmonary Artery. Preoperative Diagnosis by Selective Aortography. Kurt Amplatz, Jeorge Aguirre, and C. Walton Lillehei. J.A.M.A. **172:** 1384–1386, March 26, 1960. (University of Minnesota Hospitals, Minneapolis 14, Minn.)

The term "coronary arteriovenous fistula" is usually applied to the abnormal communications between the coronary arteries and the coronary veins, right atrium, right ventricle, or pulmonary arteries. Selective aortography has proved to be the best method of diagnosis of this type of lesion. An unusual case is reported.

A 53-year-old woman gave a four-month history of exertional dyspnea and increasing fatigue, with a bout of acute heart failure successfully treated with digitalis, diuretics, and sedatives. Cardiac fluoroscopy and heart roentgenograms revealed a generally enlarged heart without evidence of left-to-right shunt. A retrograde aortogram, with the catheter in the ascending aorta, disclosed the presence of an arteriovenous malformation obviously fed by the left coronary artery. Opacification of the pulmonary artery without staining of the right ventricle indicated a direct shunt from the coronary artery fistula into the pulmonary artery. Right heart catheterization was performed, and radioactive methyl iodide curves were obtained, by a technic previously described (Radiology **72:** 585, 1959). These curves showed a delayed left-to-right shunt at the pulmonary artery level.

At thoracotomy, clamping of the main parent artery feeding the fistula resulted in immediate response of a feebly-beating cyanotic heart. A large cavernous mass of vessels was present between the left atrial appendage, base of the pulmonary artery, and origin of the left anterior descending coronary artery. This conglomeration of vessels was fed by the left main coronary artery. The arteriovenous malformation communicated with the main pulmonary artery. The parent artery was divided at its origin from the very large left main coronary artery, and the fistulous mass was excised. The

patient made a rapid and complete recovery and was discharged after fourteen days.

Three roentgenograms; 1 diagram; 1 graph.

JOHN F. RIESSER, M.D.
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Phlebography of the Lower Extremity. Stanley M. Rogoff and James A. DeWeese. J.A.M.A. **172:** 1599–1606, April 9, 1960. (260 Crittenden Blvd., Rochester 20, N. Y.)

Deep-vein phlebography was employed to examine 251 extremities of 159 patients over a period of two and one-half years. With the patient in a semi-erect position, 60° up from the horizontal, and with a tightly occluding tourniquet placed above the ankle, 40 c.c. of 50 per cent diatrizoate (Hypaque) sodium is injected into a vein on the dorsum of the foot. For the exposures, a 14 × 36-inch cassette is used, loaded with 14 × 36-inch film or preferably with two 14 × 17-inch films butted together. At the end of injection the first radiograph of the leg is made. The tourniquet is then removed and the patient is instructed to exercise for a short period. Thirty to forty seconds after the first exposure, a second is made. The cassette tray and x-ray tube are then shifted rapidly, and a third 14 × 17-inch film is obtained of the pelvic region, in an attempt to visualize the iliac veins. Complications have been few. Most patients experienced pain in the foot during injection, and many also had pain in the calf. These symptoms disappeared promptly on return to horizontal position and on infusion of isotonic sodium chloride.

A knowledge of normal anatomy and variations is essential for the correct interpretation of phlebograms. Abnormal deep veins tend to be of two varieties: (1) Deep channels which are wider than normal and lack valves but have smooth walls and no filling defects; these changes are presumed to be due either to congenital variation or to degenerative processes but are seen in only one-third of the patients with varicose veins. (2) Patent deep veins, characterized by lack of valves and irregular walls and channels, seen in patients with histories of previous deep phlebitis; these veins are never wider than those in normal patients.

In patients with acute phlebothrombosis, deep veins which contain fresh clots may not be visible on the radiograph, or the opacified vessel may show characteristic defects.

Pitfalls of Method: Identification of the calf veins may be difficult with a single anteroposterior radiograph. Stereoscopic and lateral views are not employed routinely. Non-filling of the deep calf veins cannot alone be taken as unequivocal evidence of thrombosis, as it may represent nothing more than a failure of the method in a significant percentage of patients. This is particularly true in the case of the anterior tibial vein, since this deep vessel is most likely to be occluded near the ankle by application of the tourniquet. In patients with venous stasis associated with varicose veins or the postphlebitic state, there may be much dilution and pooling of contrast material in the foot and calf. Even after exercise, the "superficial" femoral vein may not receive enough opacified blood to allow a critical study of its lumen and valves. The iliac veins also are not dependably filled in such cases.

Failure of any of the deep calf veins to fill may be assumed to be the result of thrombosis when the other deep veins show evidence of recanalization or characteristic collateral venous bypasses. When the characteristic filling defect of a clot can be identified at the upper or lower limit of an unfilled venous segment, the authors feel that the lack of filling may reasonably be ascribed to thrombosis. If these criteria are not met, then nonfilling of a calf vein is considered, at most, only equivocal evidence of thrombosis.

Sixteen roentgenograms.

RICHARD H. GREENSPAN, M.D.
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THE DIGESTIVE SYSTEM

The Importance of Radiographic Examination of the Oesophagus and Routine Chest Radiography after Oesophagoscopy. George Cohen and Joseph Katz. South African M. J. **34:** 273–274, April 2, 1960. (Johannesburg General Hospital, Johannesburg, Union of South Africa)

Fistulas in one direction or another were found in no less than 13 (45 per cent) of 29 radiographically investigated cases of carcinoma of the esophagus. Esophagoscopy had been performed in all the patients and in some a Souttar's tube had been installed. In the 3 cases in which the fistula could definitely be traced to instrumentation, chest radiographs were obtained both before and after esophagoscopy. Such a routine is thought to be essential and, if followed generally, would increase the frequency of reports of such fistulas. In only 1 of the 13 patients were clinical symptoms observed.

The usual contrast-medium-swallow examination does not demonstrate the fistula if it passes from the esophageal wall in a somewhat upward direction either to the mediastinum or to part of the respiratory tree. Other views should be taken: the supine and/or prone with the head tilted downward, the right anterior oblique, and the left anterior oblique.

Three cases are reported, with 5 roentgenograms.

Brief Massive Spasm of Distal Esophagus Greatly Increasing Gastric Herniation, Documented Cineradiographically in a Patient with Lower Esophageal Ring. Herbert M. Stauffer, Akbar Bonakdar-pour, and Henry J. Woloshin. Gastroenterology **38:** 637–640, April 1960. (Temple University School of Medicine, Philadelphia 40, Penna.)

The authors report a case in which cinefluorography fortuitously recorded massive distal esophageal contraction with increase in gastric herniation in a patient with a "lower esophageal ring" and dysphagia. As far as could be determined, esophageal contraction of such proportions has not previously been described.

The patient was a 65-year-old white man who had suffered from slowly increasing esophageal obstruction for about twelve years. Esophagoscopy showed a hiatal hernia with stenosis of the gastroesophageal junction and mild esophagitis. A barium swallow revealed a ring-like narrowing in the lower esophageal region, but there was no delay in the passage of barium through the narrowed segment at the time of fluoroscopy. A small hiatal hernia was demonstrated. On swallowing fresh bread followed by barium, the patient experienced his usual discomfort, and a considerable delay in the passage of the barium through the lower esophagus was noted. The same procedure was repeated with image intensified cinefluorographic recording. Review of the film, including frame-by-frame analysis, disclosed that, after swallowing, the esophagus briefly underwent

marked longitudinal contraction and the barium column was pushed upward. The lower esophageal ring, maintaining its configuration and relationship to the stomach, could be seen rising along with the stomach to the level of the carina. Air and nonopaque fluid aided in identification of the supradiaphragmatic portion of the stomach; traces of barium in the rugal folds could also be seen. The stomach and the ring then descended to their usual levels. The duration of the cycle was approximately twenty-five seconds.

Two roentgenograms; 4 diagrams

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Accuracy of Roentgen Diagnosis in Carcinoma of the Stomach. John R. Amberg. Am J. Digest. Dis. **5:** 259–263, March 1960. (Milwaukee County Hospital, Milwaukee, Wisc.)

In an extensive study of the accuracy of the x-ray diagnosis in carcinoma of the stomach, the author reviewed 861 cases in which a diagnosis of gastric cancer had been made roentgenologically over a twelve-month period. In 67 patients (7.8 per cent) the roentgen diagnosis of cancer proved to be erroneous. Fifty of the 67 patients were operated on, and only 7 were found to have completely normal stomachs. Twenty-seven benign gastric ulcers were called malignant. Retrospective review of the roentgenograms in these false-positive cases did not reveal sufficient evidence to change the initial impression of carcinoma; in a few cases a technically improved examination might have prevented the error.

In 72 of the 861 cases (8.4 per cent) a false-negative x-ray diagnosis was rendered. Gastric ulcers and other lesions causing pyloric obstruction accounted for about half of the errors. Fifty-one patients from this group were operated upon and surprisingly had a 16 per cent five-year survival rate as compared to 7.8 per cent for the entire series.

A survey of the hospital records disclosed 52 cases in which a positive diagnosis of gastric cancer was made up to three years after an initial x-ray examination. The roentgenograms in these cases were reviewed, and in 29 it seemed likely that the tumor was present but had been unrecognized at the original examination. In spite of the prolonged delay in operation, the number of five-year survivors in this group was double what would be expected.

The author concludes that there will be continued reliance on the x-ray method of detecting gastric cancer. Many of the benign lesions in the false-positive group were correctly treated by removal. The false-negative group also represents very little real loss; the discovery of the error ordinarily meant that the lesion was treated properly. Actually it was in the delayed-diagnosis group that the mistakes probably were most costly. Conversion of a favorable lesion to an uncontrollable one may accompany this delay in diagnosis.

RICHARD H. GREENSPAN, M.D.
New Haven, Conn.

Carcinoma of the Stomach: An Evaluation of Diagnostic Methods Including Exfoliative Cytology. W. Burnett, P. S. Macfarlane, S. D. Scott Park, and A. W. Kay. Brit. M. J. **1:** 753–755, March 12, 1960. (The University and Western Infirmary, Glasgow, Scotland)

The authors present the results of an evaluation of the various diagnostic procedures suitable for outpatient study in gastric cancer, with particular attention to the use of exfoliative cytology as a supplement to radiology and gastroscopy. Sixty-eight patients were investigated; this number included all patients seen in two surgical out-patient clinics over a nine-month period in whom gastric carcinoma was suspected clinically. The diagnosis of gastric cancer was finally confirmed histologically in 24 patients (35.3 per cent); radical resection was carried out in 12 of the 24 cases, and a palliative resection in 5.

Barium-meal examination led to a definite or suggested diagnosis of carcinoma in 23 of the 24 proved cases. A false-negative report was made on 1 patient with a 6-mm. carcinoma of the antrum; gastroscopy likewise failed to show evidence of cancer in this instance, but cytologic study of gastric washings disclosed malignant cells. In 5 cases, the radiologist expressed doubt; in 4 of these, carcinoma was ruled out by gastroscopy and in the fifth repeat barium-meal examination revealed a healing ulcer.

Gastroscopy was performed in 22 of the 24 patients with cancer, and a definite or suspicious lesion was seen in 17. The examination was incomplete or failed in 3, due to the presence of a large carcinoma. False-negative results were obtained in 2 patients with carcinomas near the pylorus. In the non-malignant group, there were 2 false-positive reports.

Exfoliative cytology was attempted in all 68 patients but was unsuccessful in 5. Cells described as suspicious or definitely malignant were found in 13 of the 24 patients with proved carcinoma. There were 9 false-negatives in this group; in all of these cases the lesion was a huge carcinoma which was fungating or ulcerating, easily diagnosable by other methods. One apparent false-positive result was obtained, but the diagnosis was revised after the pathologist became more experienced with the technic.

The authors feel that the combined use of radiology and gastroscopy is a reliable screening method for gastric cancer. Cytology is unreliable as a screening procedure but is a valuable adjunct when routine examinations give negative results in clinically suspicious cases.

Seven photomicrographs; 4 tables.

GARTH R. DREWRY, M.D.
Tampa, Fla.

Chronic Gastric Volvulus: Symptoms of Epigastric Pain and Emesis. Creighton A. Hardin and Colvin H. Agnew. J. Kansas M. Soc. **61:** 172–174, March 1960. (University of Kansas Medical Center, Kansas City, Kans.)

A case is reported of chronic, intermittent gastric volvulus in a 58-year-old white man with a history of repeated bouts of epigastric pain with emesis over seven years. Annual barium studies of the stomach during that period had failed to demonstrate a gastric or duodenal ulcer and a gallbladder series on two occasions had been reported normal. Nonspecific findings of a hyperirritable duodenal bulb and delayed gastric emptying were described by the radiologist.

Radiographic and fluoroscopic studies with barium showed organo-axial rotation of the proximal half of the stomach, producing a partial obstruction. Two levels of layered air and fluid were seen in the obstructed stomach. A repeat barium study twenty-four hours after continuous gastric suction showed reduction

of the obstructing rotation. Gastric emptying was delayed but considerable retained fluid was present. No hiatal hernia could be demonstrated.

At surgery there was found a deficiency in the mesenteric attachment along the greater curvature of the stomach beginning at the lower pole of the spleen, permitting manual reduplication of the rotation. A 50 per cent Billroth I gastrectomy and vagotomy were performed. The postoperative course was uneventful. The excised segment of the stomach showed many acute superficial scattered ulcerations, probably secondary to the intermittent partial obstruction.

In gastric volvulus a certain atony or lengthening of peritoneal fixations must occur in the gastrosplenic, gastrophrenic, hepatogastric, and gastroduodenal ligaments with some degree of ptosis of the stomach. The omental fixation of the transverse colon is also a contributory factor because the colon may rotate with the stomach. Secondary factors are diaphragmatic hernia or eventration, tumors, peptic ulcer, and displacements by neighboring organs.

Clinical suspicion should be followed by confirmatory x-ray diagnosis. In addition to the findings reported in this case, unusual amounts of gas have been noted in the transverse colon and splenic flexure.

In acute complete volvulus there is no passage of barium.

Five roentgenograms.

Method of Roentgenologic Functional Evaluation of the Operated Stomach. W. Hiemsch. Fortschr. a. d. Geb. d. Röntgenstrahlen **92:** 395–400, April 1960. (In German) (Evangelische Diakonissenanstalt, Bremen, Germany)

Roentgen studies following gastric resection are usually unsatisfactory when ordinary barium mixtures are used; the meal tends to rush through the gastric pouch as through a rigid tube. Rapid emptying takes place within two to eight minutes, even in asymptomatic cases.

In order to prevent such hypermotility, the author has modified the contrast meal. He soaks one slice of white bread in 100 c.c. of milk and adds barium sulfate suspension up to 200 c.c. With this so-called food-contrast meal the gastric pouch appears wider and a mucosal relief pattern is formed. There is no evidence of peristalsis, but a sphincter action of the stoma is noted. Emptying slows down to periods varying from forty to sixty minutes and no longer simulates a dumping action.

The food-contrast meal was successfully tested in 55 patients who had undergone subtotal gastrectomy a year and a half to two and a half years previously for the cure of an ulcer. The effect of the modified meal on gastric motility and tonicity is well illustrated in 4 cases.

Eight roentgenograms. ERNEST KRAFT, M.D.
Northport, N. Y.

Strangulated Diaphragmatic Hernia Complicated by Gangrene of the Stomach. Lawrence Braslow, Clifford Otto Bishop, and Burford T. Burch. West. J. Surg. **68:** 120–122, March-April 1960. (4081 Brockton Ave., Riverside, Calif.)

What is believed to be the fifteenth case, since 1942, of gangrene of the stomach complicating diaphragmatic hernia occurred in a young man ten months after a traffic accident. A roentgenogram revealed a fluid-air level in the left chest at the second interspace anteriorly, with no aerated lung visible. The heart and mediastinum were markedly deviated to the right, compressing the right lung field to less than one-half its usual size, with multiple areas of small hazy patches throughout, suggesting pulmonary congestion or bronchopneumonia. The left diaphragm was not clearly visualized, and no stomach air bubble was recognized beneath it. At operation, the opening of the diaphragm through which almost all of a completely gangrenous stomach had herniated, was found to be less than 9/16 inch in diameter. This traumatic diaphragmatic opening was approximately 3 inches posterior and slightly lateral to the normal esophageal hiatus. The hernial opening was enlarged forward through the normal esophageal hiatus and a modified Heineke-Mikulicz pyloroplasty was performed. The distal esophagus was anastomosed to the remaining inch of antrum in two layers. The patient died of respiratory failure due to inability of the collapsed left lung to expand and pneumonic changes in the right lung. Pulmonary complications and/or shock were given as the cause of death in 10 of the total of 15 cases.

Clinical findings of this condition are absence of breath sounds in the left chest, with impairment of resonance, adventitious sounds, diminished expansion, cardiac displacement, asymmetry of the hypochondrium, circulatory collapse, cyanosis, and dyspnea. If trauma of the trunk, especially of the left lower chest or upper abdomen, considerably precedes the strangulation, episodes of minor pain occur. The strangulation itself is heralded by sudden, severe pain in the upper abdomen or lower chest, severe, colicky, and prostrating. Despite the unique and dramatic clinical picture, the diagnosis has invariably been missed. Early recognition and thoracotomy offer the only possibility of recovery.

Three roentgenograms; 1 photograph; 1 drawing.

Collective Review: Leiomyosarcoma of the Duodenum. T. E. Starzl, Victor M. Bernhard, and George C. Heneger. Internat. Abstr. Surg. **110:** 313–322, 1960; in Surg., Gynec. & Obst. April 1960. (Northwestern University Medical School, Chicago, Ill.)

The authors review 61 cases of duodenal leiomyosarcoma, which they believe to be all those reported. Trends in diagnosis, therapy, and prognosis are analyzed in an effort to arrive at a clearer understanding of the surgical management of these tumors. A table is presented, giving data for each case.

Peak incidence is in the forty-to-forty-nine-year age bracket. The tumor is found in both sexes with approximately the same frequency and more than half the tumors are in the second portion of the duodenum. The symptoms most often encountered are abdominal pain, intestinal bleeding, and weight loss. In a small number of cases, diarrhea, vomiting, fever, and jaundice are present. On physical examination abnormalities caused by gastrointestinal hemorrhage are the commonest findings. In a large number of cases an abdominal mass is detected preoperatively.

The roentgen gastrointestinal series is the single most useful diagnostic tool. The most common abnormality is a filling defect in the central portion of which ulceration or fistula formation has often occurred. One frequent gross pathologic finding has been the propensity of the tumor for central necrosis, a characteristic which explains both the roentgen appearance of the neoplasm and many of its clinical features.

Duodenal leiomyosarcoma metastasizes almost exclusively by local invasion and the most effective surgical therapy is radical local excision, an operation of low mortality with present-day technics. Aggressive treatment is indicated for relief of symptoms and because of the definite chance for cure in some cases.

In general, follow-up after surgical removal of these tumors has been of short duration. Because of this and because the tumor sometimes has a protracted course even without therapy, an authoritative statement on prognosis in the treated patients cannot be made.

Four tables.

Carcinoma of the Pylorus Simulating Benign Duodenal Obstruction. Charles H. Brown. Am. J. Digest. Dis. **5:** 264–273, March 1960. (Cleveland Clinic Foundation, Cleveland 6, Ohio)

Carcinoma of the pylorus may simulate benign duodenal obstruction. Three cases illustrating some of the pitfalls in the differential diagnosis of these two conditions are reported. The history of duodenal ulcer in a patient with pyloric obstruction may suggest, but certainly does not prove, that the obstruction is due to a benign ulcer. Evidence of the obstructing lesion seldom is found at the initial roentgen examination, which may show only the large dilated stomach containing food and fluid. An obstruction resulting from duodenal ulcer, however, usually responds to intensive medical therapy, and after ten to fourteen days of treatment careful roentgen studies will ordinarily establish the presence or absence of pyloric carcinoma. The importance of this follow-up examination is emphasized.

In the first of the author's cases medical management relieved the symptoms, but the correct diagnosis was delayed four and a half months because of inadequate visualization of the pylorus and duodenal bulb in the progress examinations and because of lack of cooperation of the patient. In the second case medical treatment produced no relief of an obstruction associated with a presumed duodenal ulcer of five years duration. In the third, a patient with a history of duodenal ulcer of forty years duration responded favorably to medical measures, but the progress roentgen examination suggested pyloric carcinoma. A pyloric neoplasm was found at operation in all 3 cases.

Six roentgenograms.

RICHARD H. GREENSPAN, M.D.
New Haven, Conn.

Gastric Retention During Oral Cholecystography Due to Underlying Lesions of the Stomach and Duodenum. P. Ruben Koehler, Jacob I. Fabrikant, and Edward R. Dana. Surg., Gynec. & Obst. **110:** 409–412, April 1960. (Johns Hopkins Hospital, Baltimore, Md.)

The retention of ingested cholecystographic medium in the stomach after ten to fourteen hours may be a due to the diagnosis of partial or complete gastric outlet obstruction with altered gastric motility. The authors reviewed the records and roentgenograms of 500 cases in which oral gallbladder studies had been reported as affording poor visualization or none at all. Of this group, 33 exhibited gastric retention of the opaque medium. In addition, 1,000 consecutive cholecystograms obtained at the Johns Hopkins Hospital in 1959 were studied and, of these, 12 demonstrated gastric retention. Among the total of 45 patients, duodenal ulcer was discovered in 17, carcinoma of the stomach in 4, carcinoma of the pancreas in 2, intestinal obstruction in 2, extrinsic lymphadenopathy in 1, acute or chronic cholecystitis in 9, diabetes mellitus in 2; renal disease in 2. The diagnosis was unknown in 6.

In conclusion it is stated that, although gastric retention during routine cholecystography was rare—1.2 per cent—its presence in patients with unsatisfactory opacification of the gallbladder was not uncommon—6.6 per cent.

Six roentgenograms. ROBERT E. CAMPBELL, M.D.
University of Pennsylvania

Relation of Small Bowel Resection to Nutrition in Man. M. H. Kalser, J. L. A. Roth, H. Tumen, and T. A. Johnson. Gastroenterology **38:** 605–615, April 1960. (VA Hospital, Coral Gables, Fla.)

Twenty-five patients who had undergone resection of the small bowel or a bypass operation were studied in an attempt to clarify the long-term physiologic and clinical effects of removal of various lengths of jejunum, ileum, and colon on nutrition. Resection or sidetracking of the bowel was performed in 22 patients because of chronic inflammatory disease of the intestines, either regional enteritis or enterocolitis. In the remaining 3 cases, surgery was carried out as an emergency procedure for gangrene of the bowel due to obstruction or thrombosis. On the basis of the extent of resection, the 25 cases were classified in three groups: *Group I* (6 cases): Patients with minimal resections (less than 2 feet). *Group II* (14 cases): Patients with massive resections, with terminal ileum and ileocecal valve resected or bypassed. In 12 cases one-half or more of the small bowel was removed or side-tracked. In 1 jejunosigmoidostomy was done, with resection of over 90 per cent of the intestinal tract distal to the ligament of Treitz. *Group III* (5 cases): Patients with resection of 7 to 9 feet of small bowel, with terminal ileum, ileocecal valve, and colon intact.

Postoperative studies consisted of roentgen examination, fecal-balance determination, and evaluation of the nutritional changes.

Roentgenograms of the small bowel were obtained in 11 patients following surgery, and these films were evaluated for small-bowel transit time, mucosal abnormalities, and emptying time. Determination of the length of the remaining bowel from the roentgenograms proved to be a rough estimate, and the results did not coincide with the surgical measurement in some of the cases. The transit time averaged two hours in Group I, although in 3 patients there was definite hypermotility, with the barium reaching the colon in one hour. Most of the 14 patients in Group II exhibited an accelerated transit time, with an average of 1.3 hours; 3 patients had transit times of ten, fifteen, and twenty minutes, respectively. In the third group of patients the transient time was variable; however, hypermotility was not a significant feature. Transit in patients in Group II was almost three times as rapid as in those in Group III, although the length of resected bowel was approximately the same; this indicates the importance of the ileocecal valve in regulating motility. There was definite radiologic evidence of recurrence of enteritis in 4 of the 6 patients in Group I, in 7 of the 14 patients in Group II, and in 3 of the 5 in Group III. Mucosal changes of a noninflammatory type, sometimes suggesting a "nutritional deficiency pattern" were also observed, particularly in patients in Group II. No roentgenograms showed the typical picture of idio-

pathic steatorrhea. None of the 4 patients in Group I for whom small-bowel emptying could be determined had rapid emptying, whereas 6 of 12 cases in Group II, and 2 of 5 in Group III showed this finding. In general, the shorter the small bowel, the more rapidly the barium passed into the colon and the greater the steatorrhea.

Fecal-balance studies showed that the patients in Group II had the highest degree of steatorrhea, with an average fecal fat content of 42.8 gm. daily. Resection of the ileocecal valve did not appear to be the primary factor in the production of steatorrhea. However, it seems that when a large segment of ileum (over 3 feet) is resected, the additional removal of the ileocecal valve and consequent hypermotility can increase the fecal fat loss. The ileum is probably more directly concerned with fat absorption than the jejunum. The patients in Group III, characterized by an intact ileocecal valve and colon, had the least water loss in the stool. In the absence of the valve, fecal water loss is usually related to the length of small bowel and motility.

A deficient *nutritional state* was common in the patients preoperatively, and over 90 per cent had some weight loss. In the total series, there were 9 patients who gained weight following surgery; however, 5 of these lost weight subsequently due to a recurrence with severe symptoms. Anemia was a serious problem only in patients in the second group; in 5 patients in whom bone-marrow aspirations were done, there was a dimorphic anemia, with evidence of vitamin B_{12}, folic acid, and iron deficiency. Low values for serum calcium, proteins, cholesterol, and prothrombin were obtained in some of the patients. One patient had frank tetany, and 4 patients showed roentgen evidence of moderate osteomalacia and osteoporosis. Water and mineral depletion (sodium, potassium, and chlorides) was a serious problem only in the patients with the massive resection of small bowel and colon. Endocrine dysfunction appeared to be more closely related to the nutritional status and active inflammatory disease than to the degree of steatorrhea and impaired food assimilation.

The authors state that, within certain limitations, some conclusions of clinical importance can be drawn. The ileum appears to play a major role in the absorption of fat and vitamin B_{12}. The ileocecal valve, by slowing the passage of intestinal contents into the colon, decreases the water and electrolyte loss. If a segment of terminal ileum and the ileocecal valve can be left intact, nutritional disturbances will be minimal and patients with extensive jejunoileitis can benefit from surgery. Certain deficiences must be anticipated, and adequate therapeutic measures must be instituted in patients undergoing bowel resection.

Seven tables. ANTONIO SIMAO, M.D.
Cleveland Metropolitan General Hospital

The Clinical Behavior of Sprue in the United States. Paul A. Green and Eric E. Wollaeger. Gastroenterology **38:** 399–418, March 1960. (Mayo Clinic, Rochester, Minn.)

A detailed study was made of 124 cases of primary or idiopathic sprue of at least five years duration (average 18.5 years) seen at the Mayo Clinic from 1945 through 1954. Cases of sprue secondary to pathologically recognizable diseases and to gastric or intestinal resection or anastomoses were excluded. Only 9 patients experienced the onset of the sprue while residing in the tropics; the remainder had nontropical sprue.

The disorder may occur at almost any age, but among the authors' cases it was rare after sixty; the greatest incidence was in middle life. At the time of first examination at the Clinic, the chief complaints included diarrhea in 91 cases, fatigue or anemia in 14, tetany or bone pain in 5, and flatulence, dyspepsia, or symptoms apparently unrelated to sprue in 14. Twelve patients had no history of diarrhea (defined as four or more loose stools per day). Delayed excretion of water (nocturnal polyuria) was noted in 23 patients. Glossitis or stomatitis, probably indicating malabsorption of B vitamins, was encountered in 63 of 96 cases. Impaired absorption of vitamin D and of calcium manifested itself as tetany in 44 cases and as paresthesias or bone pain in some cases. Subcutaneous or visceral bleeding, giving evidence of vitamin K deficiency, was observed in 25 of 110 cases. Loss of weight and muscle wasting were the most prominent physical signs. Gaseous distention of the abdomen, edema of the lower extremities, hypotension, skin lesions, and clubbing of the fingers were common.

Fecal fat was found to be elevated in all cases by at least one of two methods of determination (fat as per cent of total solids or grams per twenty-four hours). Stool nitrogen was frequently increased.

The small intestine was examined roentgenologically in 109 patients, and in 94 a "deficiency pattern" was demonstrated. The presence of a deficiency pattern is not pathognomonic of sprue, but it is more likely to be due to that cause than to any other condition. The roentgen examination of the small intestine is also of great value in ruling out such lesions as enteritis and tumors of the bowel. Barium-enema studies were usually normal, but occasionally the colon appeared dilated and elongated. Roentgenography of various bones was carried out in only 56 patients, *i.e.*, those with symptoms referable to the skeletal system. Evidence of demineralization was encountered in 28, including 3 with pseudofractures. In 25 of the 28 cases measurements of serum calcium and phosphorus indicated that the changes resulted from osteomalacia; in 3 they were apparently due to osteoporosis.

In the present series of cases, sprue was found to be a chronic remittent disease, not completely or permanently cured by any treatment employed, including adrenal steroids and a gluten-free diet. With adequate treatment, however, the condition was compatible with long life in many cases. The fact that even patients whose disease began during their adult years were usually underweight prior to the onset suggests the presence of an underlying constitutional defect in the function of the small bowel.

Two charts; 10 tables. GARTH R. DREWRY, M.D.
Tampa, Fla.

Carcinoma Complicating Chronic Ulcerative Colitis. Leah Shore Finkelstein, Arthur Finkelstein, and George N. Stein. West. J. Surg. **68:** 112–114, March–April 1960. (Graduate School of Medicine, University of Pennsylvania, Philadelphia 46, Penna.)

Diagnostic accuracy in recognizing carcinoma superimposed on chronic ulcerative colitis with barium enema examination was low in 8 verified cases seen at the Graduate Hospital of the University of Pennsylvania. It was hoped that a study of other examples from the literature would lead to earlier, more frequent, and more accurate perception of the development of malignant change.

The authors found 183 such cases recorded. Analysis of these and of the 8 in their own experience showed that roentgenographically over 40 per cent of the carcinomas appear as poorly defined constrictions from 1 to 8 inches in length, while a similar percentage occur as single or multiple polypoid masses. In the remainder there are sharply defined constrictions or ulcerations or no localized changes at all. Poorly defined strictures of varying length commonly occur as a result of inflammation alone. Inflammatory pseudopolypoid or granulomatous masses, as demonstrated by barium enema, are frequently indistinguishable from cancer. Unlike adenomatous polyps, inflammatory pseudopolypi rarely if ever evolve into carcinoma, but there are no reliable roentgen signs for differentiating the innocent from the potentially dangerous lesion. In the patient without colitis careful evaluation of the mucosal pattern at the site of a suspected carcinoma is one of the most valuable criteria in x-ray diagnosis, a destroyed or nodular mucosal pattern strongly favoring malignancy. In the presence of colitis, the inflammatory process itself commonly destroys the mucosal pattern or replaces it with varying degrees of nodularity.

The authors conclude that the earlier the age of onset, the more severe and extensive the involvement, and the longer its duration, the more likely is chronic ulcerative colitis to be complicated by carcinoma. The symptoms and physical findings do not lead to an early recognition of cancer. The barium study appearance mimics that of inflammatory lesions and the correct diagnosis is frequently overlooked or made too late to permit cure.

It is hoped that a proper appreciation of the obstacles will lead to a high degree of suspicion and permit earlier operative intervention with a higher percentage of cures.

Four roentgenograms.

A Clinical and Radiographic Study of Appendiceal Fecaliths: A Review of the Literature and Report of Seven Cases. Robert Carras and Marvin J. Friedenberg. Ann. Surg. **151:** 374–378, March 1960. (Mitchel AFB, N. Y.)

The most widely accepted theory regarding the mechanism of formation of calcified appendiceal fecalith implicates, in sequence: (1) abnormal appendiceal peristalsis, resulting in inspissation of feces and thereby increased bacterial activity and irritation; (2) superimposed low-grade inflammation with increased mucus secretion; (3) precipitation of calcium salts in mucus on a fecal nidus.

The typical calculus is a laminated stone, although more solid appearing stones may be found. From one to twenty-three calculi have been reported in a single appendix. They range in size from minute stones to those measuring over 2.5 cm. in diameter and 10 c.c. in volume.

The presence of calculi within normal and inflamed appendices in adults and children has been observed repeatedly, both in preoperative radiographs and in surgical and autopsy specimens. The incidence is significantly higher in inflamed appendices. Stones may be so small, or their calcium content so slight, that they cannot be delineated on preoperative roentgen examination of the abdomen. Radiography of the resected specimen frequently is required to demonstrate the presence of calcium in fecal masses, which would not have been apparent by any other means.

A history of previous attacks compatible with acute appendicitis is not usually obtained. Calculi have been observed as recently as several weeks and as remotely as four years before hospital admission for acute appendicitis with perforation. Numerous observers have reached the conclusion that perforation occurs considerably more frequently and more quickly in acute appendicitis with calculi than without calculi.

Seven cases are presented as examples of acute appendicitis in which radiopaque fecaliths were demonstrated. In most cases, the preoperative roentgenogram of the abdomen was an important adjunct in determining whether or not operation should be performed, and in 1 case it was the deciding factor. The age of these patients ranged from five to twenty-five years. In 6 cases, there was definite clinical evidence of acute appendicitis, and in all the presence of calculi was confirmed after surgery.

The radiographic demonstration of a calcified appendiceal calculus is considered adequate evidence for prophylactic appendectomy, and it is an absolute indication for operation when associated with clinical findings consistent with the diagnosis of appendicitis. This approach may reduce even further the significant mortality still associated with this disease, which causes 17,000 deaths per year in the United States.

Six roentgenograms; 1 photograph.

A. R. ABLA, M.D.
Cleveland Metropolitan General Hospital

Operative Pancreatography. Mark A. Hayes. Surg., Gynec. & Obst. **110:** 404–408, April 1960. (Yale University School of Medicine, New Haven, Conn.)

The desirability of roentgenographic visualization of the pancreatic ducts is re-emphasized. Operative pancreatography *via* duodenotomy, however, with direct intubation of the main pancreatic duct and forceful injection of the radiopaque medium is attended by definite risks.

The author describes a procedure which has been employed in 18 selected cases in the past four years. Since it is performed through the cystic duct, it does not add to the morbidity or mortality of the primary operation. An No. 18–20 French polyethylene catheter is inserted through the cystic duct into the common bile duct. This is secured in place by a snugly tied silk suture around the cystic duct. Operative cholangiography is then performed with 10 c.c. of 50 per cent Urokon. To obtain a pancreatogram, 10 to 15 mg. morphine sulfate is administered intravenously ten seconds before the injection of the opaque material. This will result in closure of the sphincter of Oddi and, if the main pancreatic duct communicates with the main bile duct at its distal end, there will be a reflux of the medium into the pancreatic ducts.

The procedure is indicated where recurrent attacks of pancreatitis are unexplained by clinical or laboratory diagnostic findings or occur without demonstrable biliary tract disease. The author feels that it contributes no additional morbidity or mortality to conventional operative cholangiography and that it probably should be coupled with that diagnostic procedure whenever the pancreas has been implicated in the disease.

In 4 of the author's 18 cases results were unsatisfactory because the pancreatic duct did not open into the common bile duct. Three cases showing significant disease are illustrated. These include a pseudocyst of

the pancreas, a stricture of the main pancreatic duct, and a small adenocarcinoma of the head of the pancreas obstructing the main duct.

Five roentgenograms; 8 drawings.

ROBERT JACOBS, M.D.
University of Pennsylvania

Contribution to the Roentgen Diagnosis of the Annular Pancreas with Reports of Two Cases, One with an Unusually Large Duodenal Dilatation. R. Walko. Fortschr. a. d. Geb. d. Röntgenstrahlen **92:** 401–407, April 1960. (In German) (Staatliche Institut für Rheuma and Bäderwesen, Budapest, Hungary)

A congenital anomaly may cause the descending portion of the duodenum to be encompassed by an annular extension of the pancreatic head. Symptoms are present only when the ring causes stenosis or compression.

Roentgen findings indicative of annular pancreas consist, in infants, of a double gastric gas bubble and, in adults, of an eccentric stenosis of the descending portion of the duodenum with prestenotic dilatation. In the differential diagnosis one has to consider congenital duodenal atresia, carcinoma of the head of the pancreas, and postbulbar duodenal neoplasms. When the ring is small, mucosal prolapse from above and below the stricture may simulate a polyp or diverticulum. Associated peptic ulcer and pancreatitis occur in approximately 25 per cent of the cases.

Two examples in adults are described and illustrated. In the first patient the prestenotic dilatation of the bulb was unusually large. In addition, there was a prepyloric ulcer with secondary pyloric stenosis. The diagnosis was surgically verified. In the second case, the duodenal stenosis was roentgenologically characteristic, as it was eccentric, with shelf formations above and below the stricture. The mucosal pattern was intact, and there was no appreciable prestenotic dilatation. Because of a coexisting reticulum-cell sarcoma of the lymph nodes, intensive radiotherapy was instituted. At autopsy a radiation-induced pancreatitis was found, which was believed to have caused the duodenal stenosis within the annular pancreas.

Six roentgenograms; 1 photomicrograph.

ERNEST KRAFT, M.D.
Northport, N. Y.

Percutaneous Lieno-Portal Venography in the Demonstration of Liver Masses. Sture Stattin. Acta radiol. **52:** 353–364, November 1959. (Sahlgrenska Sjukhuset, Gothenburg, Sweden)

Percutaneous lienoportal venography was performed 80 times by the author during the years 1955–57. The technic employed is essentially that described by Bergstrand and Ekman (Acta radiol. **47:** 269, 1957. Abst. in Radiology **70:** 286, 1958). The spleen is punctured with a 10 to 15 cm. needle of 1.5 mm. outer diameter, and 30 c.c. of 45 per cent Hypaque or 60 per cent Urografin are injected. One film is taken at the beginning of the injection, and usually seven more at two-second intervals. Because the contrast material is heavier than blood, a gravitational effect may be observed, and examination of the patient in both supine and prone positions may be necessary. Expanding lesions in the liver may produce the following changes:

Vascular displacement may be expected only in expanding lesions such as cysts and abscesses. Primary or secondary neoplasms tend to invade the vessels, especially the veins, rather than displace them.

Vascular occlusion with resulting disturbance of the hemodynamic conditions. The hepatic and portal veins may at an early stage be invaded by malignant tumor tissue, which together with thrombi may more or less obliterate their lumen. Such occlusion may be demonstrated directly or indirectly by percutaneous lienoportal venography. Some of the tributaries to the portal vein may be filled in a retrograde direction.

Defects in the homogeneous filling of the liver. The only roentgen finding which seems to be pathognomonic of space-occupying lesions of the liver is the demonstration of defects in the late phase of the examination when the liver is homogeneously filled with contrast medium. The relatively low yield of cases in the present series in which a certain diagnosis could be made during this phase was due to the fact that an insufficiently high concentration of medium was used in most instances.

[In 50 of the author's cases the indication for the examination was probable metastasis or a similar expanding lesion in the liver. It is the abstracter's impression that the disadvantages of using thorium in such cases would be negligible. The yield would probably be higher and the examination could be performed more leisurely, with tomograms obtained when indicated. In addition, a built-in contrast agent would be available on follow-up studies.—H. J. B.]

Ten roentgenograms.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Gallbladder Evacuation in the Normal Male Induced by Cholecystokinin. Paul Edholm. Acta radiol. **53:** 257–265, April 1960. (Karolinska Sjukhuset, Stockholm, Sweden)

The author studied the rate and degree of emptying of the gallbladder in the normal male, using cholecystokinin as the stimulus. Fifteen healthy medical students, between twenty-one and twenty-six years of age, were given tablets of Telepaque on two consecutive days. After ingestion of the last tablets on the second day they fasted until the next morning, when lateral and anteroposterior views of the gallbladder were obtained. The volume of the gallbladder was calculated from these roentgenograms, by a method which is described in detail. After this calculation, each subject received an intravenous injection of 75 Ivy dog units of cholecystokinin and pancreozymin dissolved in 10 ml. saline. The duration of the injection was always thirty seconds. Pairs of films were taken at intervals—for sixty-three minutes in most cases.

The initial volume of the gallbladder ranged from 14 to 60 ml., with an average of 33 ml. Following the administration of the cholecystokinin, all gallbladders evacuated a part of their contents; the greatest volume expelled was 27 ml. and the smallest 8 ml., with an average of 15 ml. The greatest decrease in volume occurred in the first fifteen minutes, with only minimal change up to thirty-one minutes, after which refilling usually began. The average evacuation at fifteen minutes was 38 per cent of the initial content.

The first fifteen minutes could be divided into three phases: rapid emptying (2 ml./min.) in the first minute; slow emptying (0.5 ml./min.) for the next two minutes, and then a period of moderate emptying (0.8 ml /min.) between three and fifteen minutes. The first phase occurs simultaneously with sudden relaxation of the sphincter; the second is due to resumption of its tonus; the third phase starts when the gallbladder tonus has

increased sufficiently to overcome that of the sphincter.

Comparable results were obtained by Boyden using a fatty meal. At fifteen minutes, however, the fatty meal emptying is proceeding at full speed, while the cholecystokinin emptying is on the decrease. The initial emptying rate is faster for cholecystokinin.

The great range of variation in emptying rate in this normal series casts doubt upon any diagnostic value of such determinations.

Five figures.

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A Roentgenologic Study of Gallbladder Evacuation Following Nonbiliary Tract Surgery. Herbert D. Gullick. Ann. Surg. **151:** 403–408, March 1960. (VA Hospital, Syracuse, N. Y.)

There is little information concerning the effect of trauma or of nonbiliary tract operations on gallbladder function. Clinical interest in this aspect of gallbladder physiology is aroused by the occurrence of acute cholecystitis following operation for disease unrelated to the biliary tract. Studies based on roentgenographic visualization following general trauma, operation, or remote disease offer conflicting interpretations regarding the concentrating ability of the gallbladder. The present investigation was designed to exclude any influence of surgical trauma on gallbladder visualization by administration of a cholecystographic medium prior to operation. Postoperative disappearance of the contrast material affords a measure of gallbladder contraction and evacuation.

The emptying time of the gallbladder was determined in 40 patients after nonbiliary tract surgery by following the disappearance of a cholecystographic density obtained prior to operation. Emptying time ranged from three to sixteen days after intra-abdominal operations and from one to ten days after extra-abdominal operations. Gallbladder evacuation was related primarily to resumption of food intake and was not inhibited specifically by surgical trauma. The average interval between food intake and gallbladder emptying after extra-abdominal operations was one day; after colectomy and abdominoperineal resection, one day; after miscellaneous intra-abdominal operations, two days; and after partial gastrectomy, four days. Emptying time was not influenced by the age of the patient, magnitude of operation, peritoneal irritation, narcotics, or intestinal peristalsis.

Motor inactivity of the gallbladder during the postoperative starvation period, concomitant biliary stasis, and obstruction of the cystic duct by inspissated material extruded from the gallbladder on resumption of food intake provide a plausible explanation for postoperative acute cholecystitis.

Two graphs.

A. R. ABLA, M.D.
Cleveland Metropolitan General Hospital

The Oral Cholangiogram. Frank W. Gearing, Jr., and N. M. Canter, Jr. Virginia M. Monthly **87:** 186–192, April 1960. (301 Professional Bldg., Harrisonburg, Va.)

The authors review some of the more recent articles on oral cholangiography and refer to their own "brief experience." While the oral method leaves something to be desired with reference to the determination of the functional capacity of the sphincter of Oddi and obstruction at this level by fibrosis, it is believed to be adequate in a large percentage of patients and is more successful in demonstrating the gallbladder and/or the biliary tree in cases where the usual repeat or double-dose examination fails. The intravenous method can be reserved for those cases in which the oral cholangiogram fails to yield the desired information.

Eighteen roentgenograms.

A Comparative Assay of Biligrafin and Perorally Effective Cholangio-Cholecystography Contrast Media (Biloptin and Related Substances). H. Ludin and Clara Lauchenauer. Schweiz. med. Wchnschr. **90:** 471–473, April 23, 1960. (In German) (Universitätsinstitut fur Röntgendiagnostik und Strahlentherapie, Basel, Switzerland)

A comparison is made of the visualization of the gallbladder and bile ducts following intravenous injection of Biligrafin Forte and the oral ingestion of Biloptin. Eighty-three patients were examined by both methods, the intervals between studies ranging from one day to a month. In 122 patients Biloptin alone was used. Biligrafin was found to be superior to Biloptin in its cholangiographic effect, although in most cases the visualization of the bile ducts was adequate after administration of the oral agent. The contrast depth of the gallbladder was only insignificantly lower after Biloptin than after Biligrafin. Side-effects occur less frequently and are milder with Biloptin than after intravenous injection of Biligrafin Forte.

Six tables.

THE MUSCULOSKELETAL SYSTEM

Unrecognized Trauma in Infants and Children. Donald H. Altman and Richard L. Smith. J. Bone & Joint Surg. **42-A:** 407–413, April 1960. (2751 Coral Way, Miami, Fla.)

In 1957 (Brit. J. Radiol. **30:** 225, 1957. Abst. in Radiology **70:** 444, 1958), Caffey pointed out the importance of recognizing traumatic lesions of the bones in children without a history of injury. The authors have recently seen 12 such cases in the Miami (Florida) area and report 5 of these in detail. Although a history of trauma was not obtainable in any of these patients, there was strong indirect evidence in each instance to indicate that trauma was actually the predisposing factor. In some cases the roentgen evidence of trauma was very apparent, as when there was a fracture of one or more long bones or flat bones. Subtle metaphyseal fractures, however, are not so obvious.

According to Caffey, the fact that the penetrating fibers of Sharpey, which are the principal attachments of periosteum to underlying bone, are scarce in the young, and that periosteal blood vessels are abundant and circulation active, explains the ease with which the periosteum is stripped from the bone and accounts for the sizable periosteal hemorrhage beneath it. The subperiosteal hemorrhage calcifies and becomes visible roentgenographically in seven to fourteen days, the shorter period in infants. The firmest attachment of the periosteum in children occurs at the insertion of the perichondrium into the metaphyseal ends of the bones. With twisting or shaking injuries, the deep anchoring or penetrating fibers of the perichondrium will lift up the cortex of the distal metaphysis. These small metaphyseal fractures, if seen very early, before the development of subperiosteal calcification, can be perplexing. More severe aggression, such as striking or throwing a child, may well result in frank long or flat-

bone fractures. Therefore, when a child is seen with metaphyseal infraction, complete bone surveys should be carried out.

The diagnosis of traumatic injury to young bones should be made with a relative degree of certainty on the initial roentgen examination and confirmed by survey films of the long bones. The early recognition of the traumatic origin of these lesions is of great importance in preventing more serious complications. In some instances the removal of the child from the environment in which such injuries occur may be life-saving.

Thirteen roentgenograms.

JOHN F. FOTOPOULOS, M.D.
Northwestern University Medical School

Primary Hyperparathyroidism. Ching Tseng Teng and M. Herbert Nathan. Am. J. Roentgenol. **83:** 716–731, April 1960. (Jefferson Davis Hospital, Houston 3, Texas)

For an excellent review of the subject of primary hyperparathyroidism, this article is highly recommended. The symptomatology, pathophysiology, and chemical changes are discussed, and the findings in 8 cases of hyperparathyroidism due to benign adenoma are presented in tabular form. Also illustrated is the healing of osseous lesions after surgery. Four of the patients exhibited advanced skeletal involvement, while in others the changes were very early or moderately advanced.

Very early skeletal changes observed in 1 patient that should have aroused suspicion of hyperparathyroidism were: minimal coarsening of the trabecular pattern in the vertebrae and pelvic bones; minimal resorption of the distal clavicle on its inferior aspects; thinning of the cortical plate of the lumbar vertebral bodies; minimal resorption at the symphysis pubis.

Moderately advanced but diagnostic changes in 1 patient were: generalized moderate decrease of bone density; thinning of cortices of bones of hands and feet, without definite subperiosteal resorption; slight resorption of inferior aspects of distal clavicle; slight resorption of medial aspect of proximal tibia; partial loss of lamina dura; cystic lesions in maxilla and mandible; coarsened trabeculae in skull, spine, ribs, and long bones; a pressure defect on the esophagus; bilateral renal calculi.

Advanced bone changes that are pathognomonic of primary hyperparathyroidism are: resorption of compact bone, both subperiosteal and endosteal, occurring in any bone, but especially in the middle phalanges of the fingers and other tubular bones of the hands and feet; subperiodontal resorption of lamina dura; subchondral resorption of clavicle and of the symphysis pubis; trabecular resorption of spongy bone, especially of the skull, hands, ribs, mandible, vertebrae, and pelvis. Roentgenographically, the skull shows a loss of density with a characteristic miliary, stippled, granular, woolly or mottled appearance; the inner and outer tables are markedly thinned. Cyst-like areas may be seen in the skull and other bones; some may grow, expand the bone, and present as palpable tumors. The jaws, the pelvis, and the femur are favorite sites.

The secondary changes of advanced hyperparathyroidism are marked bone softening, pathological fractures, and various deformities, such as kyphosis, scoliosis, and distortion of pelvis and rib cage.

Following surgical resection of the parathyroid adenoma, the bony lesions heal more or less rapidly, although the larger cystic lesions may persist after all other skeletal changes have disappeared. In 1 of the authors' cases an incompletely healed cystic lesion in the superior pubic region was demonstrable ten years after parathyroidectomy.

Twenty-nine roentgenograms; 7 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Advanced Skeletal Changes in Hyperparathyroidism. Richard M. Friedenberg and Victor Sayegh. Am. J. Roentgenol. **83:** 743–747, April 1960. (Lebanon Hospital, Bronx 57, N. Y.)

The authors present 3 cases of advanced hyperparathyroidism which illustrate all of the skeletal changes seen in this disease, namely (1) diffuse osteoporosis usually associated with a granular mottling of the skull and to a lesser extent of the long bones; (2) subperiosteal bone resorption, most often seen in the fingers, clavicles, and medial aspects of the tibia; (3) cystic changes in the bone that are in reality solid tumors of low density composed of osteoblasts and osteoclasts and are the end-results of increased metaplasia of bone; (4) periarticular calcifications often localized in areas of trauma and often associated with pathologic fractures.

It is pointed out that the advanced skeletal lesions of hyperparathyroidism are infrequently encountered by the radiologist because of early medical diagnosis of the disease.

Twelve roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Primary Hemangiopericytoma of Bone. Review of the Literature and Report of the First Case with Metastases. Raul A. Marcial-Rojas. Cancer **13:** 308–311, March-April 1960. (Oncologic Hospital, San Juan, Puerto Rico)

The author presents the fifth authenticated case of primary hemangiopericytoma of bone. This uncommon tumor is similar to the glomus tumor, first thought to occur only in the phalanges as an enlargement of the normal neuromyoarterial glomus, but later found in other locations throughout the body. Hemangiopericytoma is characterized by many capillaries, while the perivascular spaces are filled with closely packed cells, epithelioid in appearance, believed to originate from the surface of the capillaries and considered to be pericytes.

The author's patient was an 83-year-old female with a large mass involving the clavicle, increasing moderately rapidly in a three-month period. Roentgenograms showed complete destruction of the medial half of the clavicle, suggesting a malignant tumor, with soft-tissue extension. A resection was performed, but multiple pulmonary metastases ensued, and death occurred some seventeen months after resection.

This is the first reported instance of metastasis from hemangiopericytoma of bone. It is to be noted that histologic criteria for differentiating a benign from a metastasizing hemangiopericytoma are extremely unreliable.

From the meager information available, it would seem to the author that these tumors, when located in a resectable bone, should be treated surgically. In cases involving an important weight-bearing bone, radiation has proved successful. Local resection with bone graft-

ing is another possibility, as most of the tumors are of a low grade malignancy and, if adequately removed, will not recur.

One photograph; 3 photomicrographs.

CHARLES M. GREENWALD, M.D.
St. Cloud, Minn.

Skeletal Metastases from Malignant Testicular Tumors. A Report of 10 Cases with Osteolytic and Osteoblastic Changes. Paul W. Sum, Bernard Roswit, and Sol M. Unger. Am. J. Roentgenol. **83:** 704–708, April 1960. (VA Hospital, Bronx 68, N. Y.)

From a primary testicular tumor one expects pulmonary metastases. Skeletal involvement has been observed rather infrequently. The authors report 10 such cases from a group of 167 patients with neoplasms of the testis, seen or treated in the Radiation Clinic of the VA Hospital, Bronx (New York), from 1949 to 1957. The primary lesions included 5 seminomas, 4 embryonal carcinomas, and 1 teratocarcinoma. Seven patients exhibited roentgen evidence of skeletal involvement during life, with confirmation by surgical biopsy and/or autopsy. Osteolytic changes were found in 5 patients and multiple osteoblastic foci in 2; in the remaining 3 cases, metastatic bone lesions were discovered at autopsy.

The skull was the site of metastatic disease in 1 case, the vertebrae in 7, the ribs in 4, the femora in 3, the humerus in 1, and the coracoid process of the scapula in 1. Of special interest is the fact that several patients had roentgen demonstrable bone metastases before exhibiting pulmonary involvement. This is explained by Batson's view that the vertebral venous plexus is the major pathway by which tumor emboli disseminate to the axial skeleton, bypassing the lungs.

Why osteoblastic changes develop in some cases and osteolytic changes in others is not known. Willis (1952) attributes this to different enzymes produced by a particular malignant tumor.

Eleven roentgenograms; 1 table.

MAX EICHWALD, M.D.
Encino, Calif.

Osteoblastic Bone Metastasis in Gastrointestinal and Bronchial Carcinoids. Frances B. Toomey and Benjamin Felson. Am. J. Roentgenol. **83:** 709–715, April 1960. (University of Cincinnati College of Medicine, Cincinnati, Ohio)

Abdominal carcinoids are epithelial tumors arising from argentaffin cells in the crypts of Lieberkühn in the gastrointestinal tract. Carcinoids primary in the appendix are usually solitary. Those arising elsewhere in the abdomen are frequently multiple and may metastasize. Bone metastases, of special interest in the present article, are quite infrequent. The carcinoid type of pulmonary adenoma is believed to arise in the bronchial glands; it behaves like its abdominal counterpart, growing slowly, recurring late after resection, and metastasizing infrequently.

The authors report 2 cases of carcinoid with histologically verified osteoblastic bone metastases. In 1 the primary site was probably within the abdomen; in the other it was in a bronchus.

Roentgenograms of the skeleton in the first case showed numerous discrete and coalescent osteoblastic nodules in the pelvis, spine, and ribs; these progressed slowly over a four-year period of observation. The patient had abdominal symptoms, but careful roentgen examination of the small and large bowel and surgical exploration failed to reveal the primary lesion.

The second patient had a 4-cm. nodular, bronchial adenoma of the carcinoid type in the left perihilar region. Three years after its resection, roentgen examination showed an ill-defined area of increased density in the right ilium. Over the next three years widespread metastases in the soft tissues developed, with osteosclerotic lesions in the sacrum, vertebrae, and one rib.

The authors feel that the roentgenographic similarities in bone metastases from abdominal and bronchial carcinoids indicate a close relationship between the two entities.

Five roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Roentgen Manifestations of Synovial Osteochondromatosis. Charles Zimmerman and Victor Sayegh. Am. J. Roentgenol. **83:** 680–686, April 1960. (Lebanon Hospital, Bronx 57, N. Y.)

Jaffe (1958) stated that the term "synovial osteochondromatosis" is properly applicable only to a condition in which cartilaginous foci develop in joint synovia through metaplastic changes of the subsynovial connective tissue. The cartilage may then separate from the synovium, enlarge in the joint space (since it can be nourished by synovial fluid), and ultimately become calcified or ossified. Such a definition implies that, unless areas of cartilaginous metaplasia can be demonstrated microscopically, the presence of calcified or ossified joint loose bodies is not diagnostically specific. Within the limits of this definition, true synovial osteochondromatosis is uncommon. The authors report 2 cases.

The roentgen findings in synovial osteochondromatosis are: (1) soft-tissue masses of water density within the involved joint; (2) calcifications and/or ossifications representing synovial metaplastic changes to cartilage, sufficiently calcified to be radiopaque (these radiopacities are generally finely stippled and often coalesce to form amorphous irregularly bordered shadows which may involve the entire joint space); (3) erosion of adjacent subchondral bone; (4) secondary arthritic changes.

In the differential diagnosis, one must consider osteoarthritis with osteophytes and loose bodies, pigmented villonodular synovitis, synovial sarcoma, osteochondritis dissecans, neuropathic arthropathy; hemangioma, popliteal artery aneurysm, chondrosarcoma, and idiopathic intra-articular free bodies without synovial metaplasia. These conditions are discussed.

Treatment requires the surgical removal of all accessible loose bodies to prevent mechanical articular damage. Radiation therapy is not generally advocated.

Four roentgenograms; 2 photomicrographs; 2 photographs.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Observations on 100 Cases of Leukaemia in Childhood. Reginald Lightwood, Herbert Barrie, and Neville Butler. Brit. M. J. **1:** 747–752, March 12, 1960. (Hospital for Sick Children, Great Ormond Street, London, England)

Of 100 cases of leukemia admitted to the Hospital for Sick Children (London) between 1951 and 1957, 92

were acute lymphoblastic or myeloblastic, 5 acute monoblastic, 2 chronic myeloid, and 1 acute plasma-cell. The total white count was normal in nearly half the patients on admission. Abnormal white cells were present in the initial peripheral blood count in 58 per cent.

Complete or partial skeletal surveys in 50 patients showed radiologic changes in 33 (66 per cent); this incidence is probably higher than in an unselected series, because radiographs were often requested on account of skeletal symptoms. The femurs and tibias were most frequently involved; only once were they radiographically normal in the presence of bone changes elsewhere. Metaphyseal translucent bands of rarefaction were found in 88 per cent of the cases with radiographic changes; cortical changes (round translucent areas, sclerosis, spontaneous fracture, generalized rarefaction) in 61 per cent; periosteal involvement (irregularity, double contour, subperiosteal calcification) in 27 per cent. Epiphyseal changes were not observed in this series, although the authors had previously seen involvement of the femoral head resembling Perthes' disease in a 12-year-old boy with chronic myeloid leukemia. In 2 of 8 cases with radiologic changes in the spine, wedging of vertebral bodies preceded evidence of leukemia in the peripheral blood.

Sixty-three patients received one or more courses of steroids, aminopterin, or 6-mercaptopurine; 34 of these had one or more complete remissions of up to seven months in duration. A further 14 had partial remission, bringing the total number with improvement to 76 per cent. In those treated with all three drugs, the average survival time was 13.3 months, as compared to three months in untreated cases. The condition of 1 patient, in whom a meningeal syndrome with headache, vomiting, vertigo, and papilledema developed during a remission, was greatly improved following x-ray therapy to the posterior fossa, with a dose of 500 r in ten days.

Four roentgenograms; 10 tables.

GARTH R. DREWRY, M.D.
Tampa, Fla.

The Classification of Cervical Spine Injuries. Joseph E. Whitley and H. Francis Forsyth. Am. J. Roentgenol. **83:** 633–644, April 1960. (Bowman Gray School of Medicine, Winston-Salem, N. C.)

A classification of fractures of the cervical spine according to the mechanism of injury is proposed, and a series of 159 cases is analyzed. The mechanism of injury is discussed under the following headings: flexion injuries, extension injuries, combined injuries, bursting injuries, lateral flexion, and direct trauma.

Flexion injuries are usually caused by blows directed to the posterior aspect of the skull, forcing the face toward the chest. The most severe form of this type of injury occurs when, after complete dislocation anteriorly, one or both of the dislocated facets lock. Under such circumstances, the neural elements will be contused between the posterior superior aspect of the vertebral body below the dislocation and the lamina of the vertebra above.

Extension injuries are caused by forces applied to the anterior skull or face. This type of force tends to drive the occiput back toward the dorsal spine, thus stretching the anterior longitudinal ligament.

Flexion and extension injuries are subdivided into those occurring with and without compression. Complete dislocation of the facets with locking (and neurologic damage) was less common in flexion injuries with significant compression of the vertebral body; neurologic deficits are more common with extension injuries when compression of the posterior elements is present.

Combined flexion and extension injuries are surprisingly rare. Bursting fractures are caused by blows directed downward on the vertex of the skull with the spine in neutral position and may result in compression of both the anterior and posterior elements of one or more of the cervical vertebrae. This type of injury can be converted into a flexion or extension type with only a minimal angulation of the injuring force; in its pure form it is relatively rare. Lateral flexion injuries are caused by a force delivered directly to the lateral aspect of the cervical spine and skull; there is no example of this injury in the authors' series. A direct blow to the neck over a spinous process can result in a fracture of this structure. Direct injury may also be produced by penetrating missiles.

The first roentgenogram obtained in the patient with a neck injury is a lateral horizontal beam view of the cervical spine. If this shows no contraindication, open-mouth views of the odontoid and full anteroposterior roentgenograms of the cervical spine are taken. Occasionally, oblique and stereoscopic views, and oblique and lateral projections in flexion and extension, are required. Barring complicating factors, the patient remains in the radiologic department until satisfactory roentgenograms have been secured.

In the authors' series of 195 cases, 43 injuries occurred at levels C-1 and C-2, resulting in tetraplegia in 10 cases. In 9 of this group, the injury was of the flexion type. Of 116 injuries below C-1, flexion without compression was responsible for 41, and extension with compression was responsible for 37. In the entire series, there were 73 flexion injuries and 71 extension injuries.

Eighteen roentgenograms; 3 series of diagrams; 1 table.

ALFRED TENAGLIA, M.D.
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Spondylosis of the Cervical Spine with Compression of the Spinal Cord and Nerve Roots. Paul Teng. J. Bone & Joint Surg. **42-A:** 392–407, April 1960. (Kaiser Foundation Hospital, Los Angeles, Calif.)

The author discusses the mechanisms which produce compression of the spinal cord and nerve roots in spondylosis of the cervical spine with particular reference to the differential compression of the nerve roots that is sometimes observed. The study is based on 20 patients treated surgically for this condition, on anatomical studies of cadavers, and on roentgen examinations of the cervical spine. Nineteen of the 20 patients were men. The age range was from thirty-nine to seventy-two years.

Hypertrophic changes in the cervical vertebrae are common in middle and old age but only in a few patients do they produce compression of the spinal cord or nerve roots, or both. When compression does occur, the symptoms may simulate degenerative diseases of the spinal cord, such as primary lateral sclerosis, multiple sclerosis, and amyotrophic lateral sclerosis. The hypertrophic changes affect all parts of the involved vertebra, producing not only osteophytic ridges across the ventral wall of the spinal canal, but also deformities of the intervertebral foramina, enlargement of pedicles, and thickening of laminal arches. As a result, the spinal cord may be compressed from different directions rather

than only on its ventral aspect by osteophytic ridges.

The neurologic signs and symptoms in the 20 patients studied were quite variable and are discussed in detail. Roentgenograms of the cervical spine showed a reversal or straightening of the normal curvature in 9 cases. A narrowed intervertebral space was conspicuous in 4 patients, and constriction of the intervertebral foramina was seen in 11. Evidence of hypertrophic spondylosis with anterior osteophytic ridges was found in 16 patients. In 4, myelographic defects were produced by cartilaginous ridges which were later apparent at surgery. In all 20 patients more than one interspace was affected. The interspaces involved were distributed between the third cervical and the first thoracic vertebra, with those between the sixth and seventh and fifth and sixth vertebrae most frequently affected.

Laminectomy of the cervical spine was performed on all 20 patients. A hypertrophic laminal arch was found in 5 cases, arachnoid adhesions in 16, and increased vascularity and dilatation of blood vessels of the cord in 16. Congested and swollen nerve rootlets were noted in 7 patients; in 3 of these, the intradural course of the involved nerve root was markedly distorted. Atrophy of the nerve roots occurred in 3 patients. Displacement of the spinal cord and increased tension of the dentate ligaments were demonstrable in 12 patients. A ruptured intervertebral disk was found in 3.

Since this paper is the work of a neurosurgeon, the surgical results are given in considerable detail. Factors contributing to the production of signs and symptoms of involvement of the spinal cord are summarized.

Five cases illustrating the various pathological and anatomical changes in spondylosis of the cervical spine are reported. Each case represents a different manifestation of the disease with respect not only to symptomatology but also to pathology.

The prognosis in patients with spondylosis of the cervical spine depends on the duration and degree of trauma sustained by the spinal cord and nerve roots. The longer the duration and the more advanced the signs caused by atrophy of the cord and roots, the poorer is the outlook for recovery.

Six roentgenograms; 1 photograph; 2 charts; 3 tables. JOHN P. FOTOPOULOS, M.D.
Northwestern University Medical School

Calcified Cervical Discs in a Child. Frank T. Pierce, Jr., and William Hanafee. California Med. **92:** 283–284, April 1960. (University of California at Los Angeles, Los Angeles 24, Calif.)

A seven-year-old white boy was seen because of pain in the neck and right shoulder and slight elevation of temperature, following two recent falls. At this time the only significant physical finding was pronounced left sternocleidomastoid muscle spasm. Roentgen examination of the cervical spine disclosed extensive calcification of the disks between C-4 and C-5 and between C-6 and C-7. There was some associated loss of cervical lordosis. Laminagrams made about one month later revealed slight but definite regression of the disk calcifications; six months after this, roentgen studies showed almost complete disappearance of the calcification at C4-C5, and the C6-C7 calcification was decidedly diminished. Survey films revealed no similar calcifications in the thoracic and lumbar areas.

In an old roentgenogram taken for fracture of the clavicle when the patient was two and a half years old, the lower cervical spine was incidentally visualized; no disk calcification was apparent. There was no history of excessive vitamin D intake, and there was no evidence of systemic disease.

The authors speculate as to the etiology of disk calcification in childhood but reach no firm conclusion. In their patient they feel that the calcified disk was an incidental finding and unrelated to the recent minor trauma the child had suffered. Perhaps disk calcification in children may appear and disappear without obvious clinical manifestation and hence is never discovered in the majority of instances.

Three roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Low Back Disorders. Value of Radiographs of the Dorsal Vertebrae in Evaluating the Etiology of Lumbosacral Derangements. C. J. Sutro, D. E. Ehrlich, and M. Witten. Bull. Hosp. Joint Dis. **21:** 42–49, April 1960. (D.E.E., 9 Joval Court, Brooklyn, N.Y.)

Since the lower dorsal nerves innervate the skin in the lumbar, sacroiliac, and femoral trochanteric regions, lesions situated in the lower dorsal vertebrae or in their contiguous soft parts may cause referred pains in the lumbar or pelvic regions. The authors emphasize the necessity of including roentgenograms of the dorsal vertebrae, in addition to those of the lumbar spine and pelvis, in the examination of all patients with low-back disorders. Segmental or piecemeal roentgen study of the vertebral column based solely on the local sites of pain or tenderness should be discouraged.

Several examples are cited to illustrate the shortcomings of segmental examination: a case of osteomyelitis of the bodies of the 12th dorsal and lst lumbar vertebrae; a case of extensive ossification of the anterior and lateral ligaments of the dorsal spine; and a case of destruction of the disk tissues between the 11th and 12th dorsal vertebral bodies. In each instance roentgenograms of the lumbar spine and pelvic bones had been negative.

Six roentgenograms. JOHN P. FOTOPOULOS, M.D.
Northwestern University Medical School

Backache from Lumbosacral Instability. Maurice H. Herzmark. Bull. Hosp. Joint Dis. **21:** 50–64, April 1960. (1612 Rhode Island Ave., N. W., Washington 6, D. C.)

The author directs attention to instability of the lumbosacral apparatus as a definite cause of backache. He feels that every case of persistent or recurring backache deserves careful study from the standpoint of instability as a causative factor. Roentgenography often reveals a variety of anomalies or variations, such as lumbarization, sacralization, asymmetrical processes and facets, failures of fusion, malpositions, pseudoarticulations, and tumors. But luxations are demonstrated only by specially postured x-ray studies. If routine roentgenograms show narrowing of the lumbosacral interspace, films should be taken with the patient in the standing or recumbent position, with the spine flexed and hyperextended. Presumptive evidence of abnormal mobility may be adduced when there is spurring of juxta-articular margins without arthritic changes. Some cases show nerve changes characteristic of disk herniation, due to impingement upon the nerve roots by the narrowed foramina or sliding vertebral bodies; when these signs are present, myelography should be performed. The demonstration of luxation by flexion and extension studies or of narrowing of the

lumbosacral interspace with a negative myelogram is absolute evidence of lumbosacral instability.

The height and resilience of the intervertebral disk is the key to stability of the lumbosacral apparatus. Loss of disk material loosens the ligaments and narrows the foramina so as to cause impingement on nerves, permits sliding of the bodies, puts undue strain on the small articulations, and gives the spinal muscles the extra burden of maintaining stability, hence spasm and chronic fibrositis.

The management of lumbosacral instability is discussed. Irrespective of the cause, stabilization is indicated. The author believes that fusion should be done following removal of intervertebral disk structures, as their loss is a prime cause of instability.

Eight roentgenograms; 2 photographs; 1 drawing.

JOHN P. FOTOPOULOS, M.D.
Northestern University Medical School

Discography: Technique and Interpretation. Charles Keck. Arch. Surg. **80:** 580–585, April 1960. (Fort Hood, Killeen, Texas)

The author describes his technic for lumbar discography and discusses the interpretation of the discograms obtained.

Following premedication (usually with meperidine hydrochloride and secobarbital), the patient is placed on the x-ray table in the flexed left lateral position. Procaine is used for local infiltrative anesthesia. The L4-L5 and L5-Sl disks are studied routinely, and the L3-L4 disk when indicated. Each intervertebral space is penetrated by a 4-inch 22-gauge needle with stylet, introduced 1.5 cm. parasagittally. Ideally, the needle punctures the ligamentum flavum just medial to the facet, passing lateral to the dura and medial to the nerve root. As the needle passes through the ligamentum flavum, a definite resistance can be felt. No further resistance is noted until the annulus fibrosus is encountered. After annulus puncture, the needle is inserted about 1 cm. further. Satisfactory position of all needles is verified roentgenographically before injection of a mixture of 3 c.c. of 70 per cent iodopyracet and 1 c.c. of a solution containing 50 mg. of hydrocortisone. A lateral view is taken after each disk injection, followed by anteroposterior and oblique projections.

The normal nucleus pulposus accepts 0.5 to 1.0 c.c. of contrast material which forms a centrally located unilocular or bilocular mass; the patient may feel nothing or may experience mild discomfort. The degenerated nucleus accepts 1 to 3 c.c. of contrast material, which forms an irregular collection with spreading, layering, and separation; the patient's low-back or sciatic pain may be reproduced. The ruptured nucleus accepts an "unlimited" quantity of contrast medium which, in addition to exhibiting irregularity, protrudes beyond the intervertebral space, often dissecting beneath the posterior longitudinal ligament or dura. The back pain is reproduced.

The article is illustrated only by drawings. No results of the clinical use of discography are included.

PHILIP M. JOHNSON, M.D.
Montclair, N. J.

Fractures of the Triquetrum. Lloyd K. Mark. Am. J. Roentgenol. **83:** 676–679, April 1960. (Mt. Sinai Hospital, Milwaukee 3, Wisc.)

Fractures of the triquetrum are seen infrequently but are the second most common form of carpal injury. They often accompany more important injuries of the wrist. Roentgen examination is diagnostic and reveals two types of fracture. Small linear fissures or comminuted *fractures of the body* of the triquetrum are rare and are usually associated with the more common fractures of the dorsum; they are undisplaced, heal without treatment or complications, and cause no functional impairment. Their recognition depends upon a high degree of suspicion. A postero-anterior view with the wrist in radial deviation will best demonstrate the fracture line, separating the normally superimposed triquetrum from the pisiform. *Fractures of the dorsal surface* of the triquetrum in the nature of chip, flake, traction, or avulsion fragments comprise over 90 per cent of all triquetral injuries. Best visualized in lateral and oblique views, they appear as single or multiple fragments, ranging in size from a millimeter to over a centimeter. These fractures are frequently missed and called sprains, receiving improper and inadequate treatment, with persistent pain and impaired function of the wrist. Prompt recognition of the fracture followed by immobilization for a few weeks assures total functional recovery.

The roentgen appearance of triquetral fractures cannot be used as a guide to therapy, since the degree of deformity or nonunion is unrelated to the restoration of function, which is usually complete.

Eight roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Short Metacarpal or Metatarsal Bones: Pseudo-Pseudohypoparathyroidism. H. Hortling, E. Puupponen, and K. Koski. J. Clin. Endocrinol. **20:** 466–472, March 1960. (University of Helsinki, Finland)

The occurrence of short metacarpal or metatarsal bones is described in 1 patient who fulfilled the original description of pseudo-pseudohypoparathyroidism but without peripheral calcifications, in 1 patient with Turner's syndrome, and in 6 persons of normal height, distributed in two families. In a general population consisting of 764 persons no examples of short metacarpals were found.

The authors believe that the anomaly is more likely to occur without rather than with disturbances of calcium metabolism, since no cases of tetany were observed in this group. Associated disturbances are Turner's syndrome, as in 1 of the present series, and osteogenesis imperfecta; a thick-set body and rounded face seem also to be common. The overall conclusion is that short metacarpal or metatarsal bones appear to have no special clinical significance. Their occurrence, however, indicates that it would be worthwhile to look for other congenital disorders, including those of the endocrine system.

Seven roentgenograms; 1 photograph; 1 chart.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

THE GENITOURINARY SYSTEM

Cineurography. Robert A. Garrett and Eugene C. Klatte. J. Urol. **83:** 498–500, April 1960. (Indiana University School of Medicine, Indianapolis, Ind.)

Cinefluorography may be applied to excretory urography, retrograde pyelography, antegrade urography, cystography, and particularly voiding cystourethrography. Such examinations are designated "cineurog-

raphy." The authors present their experience with this technic at the Indiana University Medical Center.

Five-inch Westinghouse and Philips image intensifiers were adapted to standard fluoroscopic tables. A special sling which facilitated positioning for voiding cystourethrography was constructed. Cinefluorography was performed at eight to fifteen frames per second with a 16-mm. cine camera, employing Linagraph Shellburst film. The average technical factors for a six-year-old child are 70–80 kv at 2–6 ma. The gonadal dose measurements performed on a paper-maché phantom of a child of that age proved to be less with cineurography than with accepted diagnostic radiological procedures.

The advantages of cineurography as opposed to other radiographic procedures in urology are evident in the evaluation of urinary dynamics. For example, this method may yield valuable information on ureteral tonicity and momentary ureteral reflux. It may be especially useful in the incontinent patient. The main disadvantages are cost and the consumption of time.

No data concerning the number of patients examined with cineurography are given.

Six roentgenograms; 1 photograph; 1 table.

ROMAN MARCINIAK, M.D.
University of Pennsylvania

Fluoroscopic Examination of the Urinary Tract. Alvin C. Wyman and Christian V. Cimmino. J. Urol. **83:** 501–505, April 1960. (Mary Washington Hospital, Fredericksburg, Va.)

Examination of the urinary tract by fluoroscopy and spot-film radiography during excretory or retrograde urography, as a complement to these standard procedures, under certain conditions, can be a valuable diagnostic aid.

The authors claim that the standard urographic procedures, even with the "shrewdest calculation and placement of the patient," may fail in precise demonstration of the pathological process. Fluoroscopy and spot-filming can eliminate much of the "blindness" of the examination and permit a prompt demonstration of the pathologic process.

The guiding principle for the election of fluoroscopy is the suspected presence of an abnormality, in an ill patient, requiring accurate resolution.

Five illustrative cases are reported:

The first two cases demonstrate the value of the procedure in differentiating inflammatory processes from tumors. The irritability, spasm, and contraction of the renal pelvis, infundibula, and calyces may be observed fluoroscopically, and with appropriate spot-films, the inflammatory nature of the defect will be recognized.

The third case illustrates the rapid and precise identification of a ureteral obstructive process, a stricture at the ureteropelvic junction, by aid of fluoroscopy and spot-film radiography after both excretory urography and preliminary retrograde filling failed to detect the exact abnormality causing unilateral hydronephrosis.

The last two cases show that by observing under the fluoroscope the expansibility of the collecting structures or the compressibility of a space-occupying renal mass, one can gather some indication of its nature, whether it be a solid tumor possessing no compressibility at all or a renal cyst having some degree of compressibility.

Seventeen roentgenograms.

JAMES T. T. CHEN, M.D.
University of Pennsylvania

The Limitations of the Intravenous Pyelogram as a Test of Renal Function. William W. Hoffman and John T. Grayhack. Surg., Gynec. & Obst. **110:** 503–509, April 1960. (J. T. G., VA Research Hospital, Chicago, Ill.)

Eight case reports are presented to illustrate the limitations of intravenous pyelography as an indication of renal function. In all of these, excretion and good concentration of the contrast medium were observed on the intravenous pyelograms in spite of functional disturbances as determined by other tests. Normal intravenous urograms were obtained in patients with elevations of blood urea nitrogen up to 70 mg. per cent. Other parameters of renal function, such as PSP excretion and urea clearances, reflected comparable impairment of renal function. In one case an essentially normal urogram that showed good visualization was obtained in the presence of acute severe proliferative glomerulonephritis. The diagnosis was made on biopsy forty-eight hours after the urogram was obtained.

The authors emphasize that conclusions regarding the functional adequacy of the kidneys based on the findings of excretory urography are not fully justified, particularly if the pyelographic evidence is to be the sole criterion for assuming the ability of a kidney to maintain life following the removal of its mate.

Twenty-three roentgenograms.

H. W. SCOTT, M.D.
University of Pennsylvania

Renal Angiography Records Information About the Renal Arterial System. Colvin H. Agnew. J Kansas M. Soc. **61:** 142–144, March 1960. (University of Kansas Medical Center, Kansas City, Kans.)

The advantages of selective renal angiography are precise demonstration of the renal artery and kidney, minimal visualization of irrelevant areas, elimination of intramural injection and reduction of amount of contrast medium, allowance of unrestricted positioning of the patient, and reduction of the requirement for analgesia. The disadvantages are the requirement of more time, the possibility of failure in tortuous vessels or of entrance into the wrong vessel, danger of reaction to the catheter, increased radiation to the patient and operator, need for serial filming, and the possibility of overlooking aberrant arteries. This last may be minimized by injecting the aorta with sufficient contrast material to fill any other remote vessels before withdrawal of the catheter.

It would appear that angiography of the kidneys has its principal value in the investigation of hypertension and it is advocated in hypertensive patients regardless of age or duration of disease if a disparity in kidney size is shown by intravenous pyelography. It is useful in unexplained hypertension in childhood and is justified in older persons by an accelerated rise in blood pressure. Judicious employment of the method will reduce the number of unnecessary exposures.

For renal angiography the author prefers the radiopaque catheter because it may be easily seen and a tip may be molded for the specific application.

Three angiograms; 1 photograph.

Management of Renal Injuries. Stanley D. Chovnick and Harry R. Newman. J. Urol. **83:** 330–336, April 1960. (Albert Einstein College of Medicine, New York 61, N. Y.)

The authors saw 31 cases of renal injury in three and

a half years. Twenty-three are classed as minor injuries. These were treated conservatively, with strict bed rest, antibiotics, analgesics, blood replacements if necessary, and careful observation. Gross hematuria was observed in 14 cases in this group and microscopic hematuria in 9. Two of the minor injuries complicated congenital anomalies.

In 8 cases there was major parenchymal damage with or without proved urinary extravasation. There were 2 deaths in this group. Two of the remaining 6 cases were penetrating injuries which were explored immediately after excretory urography. In both of these cases exploration and simple drainage of the retroperitoneal area produced excellent results despite evidence of laceration and extravasation preoperatively. The 4 remaining major injuries, of the closed type, were treated by nephrectomy (2 cases), repair (1 case), and simple drainage (1 case).

Roentgenographic data were obtained in 30 patients. In 16 cases excretory urograms were completely satisfactory for diagnosis. Twelve were considered entirely normal, and in this group 10 patients had benign hospital courses. In 2, repeated examination, with retrograde studies, showed ruptured kidneys with extravasation of opaque medium at a time which corresponded to a deterioration in the clinical course. The remaining 4 patients with satisfactory excretory urograms included the 2 with stab wounds and the 2 with associated pre-existing lesions on the traumatized side.

In 14 patients excretory pyelograms were unsatisfactory. One showed nonexcretion bilaterally and one on the side of trauma. The first of these died of shock unrelated to the urologic injury; the second required two subsequent retrograde examinations before laceration and extravasation were diagnosed. In 6 cases with poor visualization repeat excretory urograms were normal and the clinical course was benign. In 2 instances there was incomplete filling of the calyceal system, perhaps due to blood clot. In these cases also repeat studies were normal and the course was favorable. Four patients had displaced kidneys with irregular contours and possible perirenal hematomas.

The authors believe that demonstration of extravasation of opaque medium on excretory and retrograde pyelography is not *per se* indicative of serious sequelae. The degree of danger is more dependent on such related factors as extent of injury, presence of infection, the presence or absence of obstruction below the point of injury, coexisting renal disease and, most important, upon whether or not the extravasation is progressive. Another consideration, especially in those cases of renal injury where extravasation is demonstrated on pyelography together with a fairly intact renal architecture, is whether this extravasation actually represents a rupture or is a manifestation of renal backflow that by itself is of no surgical consequence.

The fact that there was a large percentage of poorly visualizing and nonexcreting so-called "damaged" kidneys, as compared to almost 100 per cent of satisfactory excretory pyelograms on the uninjured side, points to some physiologic imbalance of the traumatized kidney with relative shock and urinary suppression occurring and continuing for a variable time. Domrich (Ztschr. f. Urol. **32**: 78, 1938) has shown experimentally that kidney function continues after trauma as long as the tissue and renal blood supply are intact, but during recovery secretion of a traumatized and intact kidney is markedly reduced.

From the authors' data, it was apparent that excretory urography repeated one to three days after injury was quite satisfactory in another 30 per cent of cases where there was poor visualization initially. Only four retrograde studies were performed for diagnosis in closed injuries, and in all there was some indication on excretory urography, together with a change in the clinical course, to warrant further clarification of the situation by retrograde examination.

Cystoscopy and retrograde pyelography should not be done routinely in kidney trauma, but should be used under specific conditions for determining operability, and deciding on the type of surgery.

The remainder of this paper is devoted to the principles of surgical treatment. The problems of late complications and secondary hemorrhage should be always considered and dealt with as they arise. The authors believe that their major responsibility after maintaining life in renal injuries is to conserve renal tissue and that prophylactic nephrectomies are not warranted.

Ten roentgenograms.

WINAND TIMMERMANS, M.D.
University of Pennsylvania

Athlete's Kidney. A. H. Kleiman. J. Urol. **83**: 321–329, April 1960. (New York Polyclinic Medical School and Hospital, New York, N. Y.)

As a consequence of repeated trauma and strenuous exercise, a distinctive renal lesion characterized by pericalyceal and peripelvic deformity may develop. This may be superimposed upon an underlying congenital anomaly, hydronephrosis, or ptosis of the kidney. The present report is based on a study of some 1,111 athletes, including boxers, wrestlers, basketball players, and hockey players, who were investigated urologically before and after strenuous exercise. Among those athletes with significant recurrent hematuria (more than 6 red blood cells per high-power field), a high percentage displayed distortion of the renal outline on the roentgenogram. Three types of distortion were encountered, involving the calyces, the pelvis, and the ureteropelvic junction, respectively.

Calyceal changes were most frequent. The minor calyces showed compression, dilatation, and clubbing. In the infundibulum the alterations varied from pronounced elongation to marked shortening. The right upper calyx was involved most often. Occasionally, the pelvis may be distorted into bizarre shapes. The normally smooth outline may be distorted by cicatricial proliferation. Pelvic atrophy or hydronephrosis may occur in various stages of development. Infrequently, the ureteropelvic junction may be involved.

Symptoms were rare, except for gross hematuria, which was found only among the boxers.

The defects in the kidney were felt to result from direct blows, forced crouching, and marked physical exertion. Pathologically, these upper urinary tract deformities were considered secondary to hemorrhage with resultant scar formation.

Sixteen roentgenograms; 10 drawings; 3 tables.

MILTON A. FRIEDLANDER, M.D.
University of Pennsylvania

Roentgen Diagnosis of Ureterocele and Some Impeding Factors. Arne E. Nilson. Acta radiol. **52**: 365–368, November 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

For urography to make possible the demonstration of

a ureterocele, the relationship between the inflow and outflow of contrast material must be such that the cyst-like portion of the ureter is distended. A relative decrease in the flow of the medium into the ureterocele, as may occur when the ureter is partially obstructed, or an increase in the flow from the ureterocele, as following dilatation of the orifice, may prevent this distention. Inflammation and adjacent masses may also prevent distention due to limitation of space.

Five roentgenograms.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Cavography in Cases of Testis Tumors. Jorge Lockhart, A. Gorlero Armas, and Hector J. Pollero. J. Urol. **83:** 438–444, April 1960. (Hospital Italiano, Montevideo, Uruguay)

The authors stress the value of cavography as a method for the diagnosis of retroperitoneal diseases and in particular lymph node metastases from tumors of the testes.

After preparation of the patient—two enemas in the twenty-four hours preceding the examination, a twelve-hour fast, and premedication—the inferior saphenous vein is exposed under local anesthesia in Scarpa's triangle and a plastic catheter is inserted into the vein up to the external iliac vein. This technic is preferred to that of Seldinger for this particular examination.

Twenty cubic centimeters of contrast material, injected manually, is generally sufficient to provide good visualization of the vena cava. No accidents have occurred in the authors' experience. The examination is highly valuable in diagnosing "ganglionic diseases" [lymph node involvement?] secondary to tumors of the testes, uterus, or rectum, or primary adenopathies; retroperitoneal tumors of renal or suprarenal origin; invasion of the wall of the vena cava by thrombophlebitis; and hepatic and splenic diseases.

The close relation of lymph nodes to the right border and posterior aspect of the vena cava and the simplicity of this technic make it a reliable means of investigation which might be systematically used each time a tumor of the testis is studied.

The radiologic signs vary with the extent of the metastatic process. They include: (*a*) flattening of the vena cava, a double contour, and lacunar images due to extrinsic compression along the vessel or at the level of the "affluence" of iliac veins; (*b*) partial or total disappearance of the veins in a series of films; (*c*) collateral circulation (not usually viewed in normal persons).

The authors believe that this method may be the key to the interpretation of radiating pains and psoitis and that it may indicate the possible treatment in such cases, either by radiotherapy or surgery.

Twelve roentgenograms.

ROGER MALTAIS, M.D.
University of Pennsylvania

THE ADRENALS

Nonfunctioning Carcinoma of the Adrenal Cortex. Charles D. Knight, B. E. Trichel, and W. R. Mathews. Ann. Surg. **151:** 349–358, March 1960. (Highland Clinic, Shreveport, La.)

The authors summarize the clinical and pathological features of 7 cases of carcinoma of the adrenal cortex in patients who exhibited no evidence of endocrine dysfunction. These tumors are therefore of the rare nonhormonal type.

Because of the absence of hormonal disturbances, the diagnosis of nonfunctioning adrenal cortical carcinoma is rarely made early. The presenting symptoms are commonly due to the large size of the tumor or to metastasis. Five of the authors' patients complained of pain in the upper abdomen; 3 had a definitely palpable mass, and 1 had soreness of the mouth and lower jaw caused by a metastatic lesion of the mandible.

Radiologic examination of the urinary tract, either by intravenous or retrograde pyelography, is sufficient in most instances to localize the pathologic process and suggest the diagnosis. Additional studies such as aortography or retroperitoneal air insufflation are seldom necessary because of the large size of the tumor. In 5 of the 7 patients in the present series, definite abnormality was demonstrated by pyelography. Pyelograms were reported as normal in 1 patient, but these films were not available for review. Calcification was visualized within the tumor in 1 case. Although the presence of calcium in adrenal tumors favors malignancy, it is not pathognomonic. In 1 instance the tumor was suggested by a retroperitoneal air study.

The left adrenal gland has been involved by this type of malignant tumor much more frequently than the right; in one reported series, the ratio was 2 to 1. All of the authors' patients had left-sided tumors.

The only successful treatment for nonfunctioning carcinoma of the adrenal cortex is surgical excision; a thoraco-abdominal approach is advocated. All of the patients in the present series were explored. The tumors removed ranged in weight from 300 to 1,050 grams. Some showed areas of cystic degeneration, hemorrhage, and necrosis. Infiltration of kidney and surrounding structures, including the lymph nodes, sometimes rendered adequate resection impossible. Palliative resection was carried out in 2 patients, and in a third only a biopsy was performed.

Nonfunctioning carcinoma of the adrenal cortex is a highly lethal tumor. The reported operative mortality is 12 to 15 per cent. One patient in the present series died within seven days of operation. Another was alive and well at the time of this report, nine years after treatment, but in this case the diagnosis of malignant neoplasm is questioned. The remaining 5 patients were either dead or living with evidence of recurrence within a period of three years following surgery. One patient who received cobalt-60 therapy after biopsy of an unresectable tumor had lived sixteen months after treatment but still had an obvious tumor.

The authors emphasize the difficulty in differentiating, even histologically, between benign and malignant tumors of the adrenal cortex. Capsular invasion and distant metastases are the most reliable criteria of malignancy.

Seven roentgenograms; 7 photomicrographs; 3 photographs; 1 table.

ANTONIO SIMAO, M.D.
Cleveland Metropolitan General Hospital

RETROPERITONEAL TUMORS

Radiology in the Diagnosis of Retroperitoneal Tumours. R. A. Kemp Harper. Clin. Radiol. (J. Fac. Radiologists) **11:** 69–79, April 1960. (St. Bartholomew's Hospital, London, England)

Because of the difficulties associated with the diagno-

sis of retroperitoneal tumors, there is a tendency to seize upon and use more complex radiological technics as they are evolved, before the possibilities of the simple methods have been fully explored. The author reemphasizes the value of gastrointestinal and urological studies as a basis for investigation of all retroperitoneal tumors. These examinations are used primarily to exclude intrinsic tumors, to locate or demonstrate a mass, and finally to give a lead to the next line of investigation.

In the gastrointestinal tract, displacements of relatively fixed points should be watched for. These are the gastric attachments, the descending limb of the duodenum, the duodeno-jejunal flexure, the colonic flexures, and the apposition of the colon and rectum to the posterior abdominal wall and the sacrum. In studies of the urinary tract, displacement of the kidney or ureters is of prime importance.

Thirteen cases are presented briefly to illustrate some of the differential diagnostic features. A few of these to which attention is called follow:

Mesenteric masses, which often displace coils of intestine, may infiltrate posteriorly and, conversely, tumors arising behind the peritoneum may invade the mesentery. It may be difficult to differentiate one type from the other but the posteriorly situated mass usually flattens rather than displaces laterally the loops of small bowel.

Tumors arising in the splenic region are difficult to differentiate from those involving the spleen itself; aortography or pneumography may be helpful. Lateral films are a requisite part of the examination.

In the upper right abdomen, the lateral view is of great value in excluding anterior displacement of the hepatic flexure, which does not occur with enlargement of the liver. With a mass in the region of the head of the pancreas or porta hepatis, splenoportography may be of assistance.

A retroperitoneal tumor surrounding the kidney usually interferes less with renal function and causes less distortion of the pelvis and calyces than does an intrinsic renal tumor.

In the lower abdomen, inflammatory masses are usually associated with the colon or produce colonic deformity. Only retroperitoneal tumors displace the rectum and pelvic colon anteriorly with increase in size of the retrosacral space as seen in the lateral view.

[Some of the clinical aspects of retroperitoneal tumors are discussed by Corbett in the same issue of Clinical Radiology (pp. 83–84). Treatment is discussed by Williams (see this issue of RADIOLOGY, p. 338)—Ed.]

Twenty-three roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

CONTRAST MEDIA

Experiences with Duografin. William H. Shehadi. Acta radiol. **53**: 284–288, April 1960. (Department of Radiology, New York Polyclinic Medical School and Hospital, New York, N. Y.)

Duografin is a combination of Renografin and Cholografin-methylglucamine (Biligrafin Forte). This medium was employed by the author in 300 patients who were referred for an examination of the urinary and/or biliary tract, or for a general check-up. Intravenous injection of 50 ml. results in simultaneous, consistent, and adequate demonstration of the biliary and urinary tracts at a single session. Preparation is essentially the same as for urography and cholegraphy, consisting of catharsis and dehydration. The urinary tract is examined first, with the patient supine. The bile ducts are then examined, without change of position, except that the left side may be elevated 15° or more, if necessary, to prevent overlap of the biliary tract with the right renal pelvis and ureter and the spine. When the gallbladder is filled with contrast medium, the patient is turned to the prone position, and the examination is concluded in the usual manner.

The results of the double study have been gratifying. It is most convenient for the patient, since he has to make only one visit to the x-ray department and only one preparation is required. While the procedure is time-consuming for the radiologist, it takes less time than two separately conducted examinations.

The incidence of side-reactions was not significant. Contraindications are the same as for cholegraphy and urography.

Five roentgenograms. PAUL H. MOORE, M.D.
University of Florida, Gainesville, Fla.

RADIOTHERAPY

Analysis of Sites and Causes of Treatment Failures in Squamous Cell Carcinomas of the Oral Cavity. Gilbert H. Fletcher, William S. MacComb, and Ernest J. Braun. Am. J. Roentgenol. **83**: 405–411, March 1960. (University of Texas M. D. Anderson Hospital and Tumor Institute, Houston 25, Texas)

This study was limited to 224 patients with squamous-cell carcinoma of the oral cavity previously untreated. Patients not treated because of advanced disease and patients refusing treatment were counted as failures.

The staging of the primary lesion was based on the original findings and was never changed. Extensions from the primary site and metastatic disease of the neck were staged separately. The locations and varying types of structures were given different degrees of emphasis on staging any particular original lesion. A dual system of operational charts based on information noted above was available for analysis.

Lesions of the anterior two-thirds of the tongue, floor of mouth, gum, and buccal mucosa have a decreasing tendency to metastasize. Thus, the salvage rate for metastatic neck disease is lowest in patients having involvement of the anterior two-thirds of the tongue and highest for patients with lesions of the buccal mucosa. No patients were alive even at three years with bilateral neck lymph-node metastases from tongue lesions, but there was a significant salvage rate for those with lymph-node metastases from the floor of the mouth.

Uncontrolled disease of the neck alone, or in conjunction with lack of control of the primary lesion, is a common cause for treatment failure. If the cervical lymph-node metastases do not exceed 3 cm. in diameter, a very satisfactory salvage rate is obtained.

This is an excellent analysis and should be read in the original by all who treat oral cancers.

Six tables. JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

End Results and Causes of Failure in Treatment of Intraoral Carcinoma. Lewis W. Guiss and Ian Macdonald. Am. J. Roentgenol. **83:** 412–420, March 1960. (University of Southern California School of Medicine, Los Angeles, Calif.)

The authors' experience in the management of intraoral carcinoma arising in several anatomic sites is presented. All cases accepted for treatment in their private practice during the study period, and followed for five or more years, are included. The varied clinical data were reduced as accurately as possible to common denominators with reference to size and location of lesions, status of lymph-node involvement, method of treatment, control of disease, causes of death, and reasons for therapeutic failure. This information was transferred to punch cards for analysis. The lesions analyzed were cancers of the anterior two-thirds of the tongue, alveolar ridge, buccal mucosa, floor of the mouth, and hard palate.

There is an excellent discussion of each area with tables showing the response to treatment. The authors' own summary is as follows:

"Epidermoid carcinoma of the intraoral cavity is a relatively curable disease if treated before there are metastases. Determinate five-year cure rates around 90 per cent may be expected for cases without lymph-node involvement.

"Treatment of intraoral carcinoma complicated by spread to the lymph nodes is much more difficult, the five-year salvage figures for this group being but 10 per cent.

"Depending on the ratio of cases with and without lymph-node involvement, the over-all five-year salvage should average about 50 per cent for the various intraoral sites anterior to the tonsillar pillars.

"Earlier application of 'elective' radical neck dissection to cases regarded as likely to develop lymph-node metastases some time in their clinical course appears to offer potential improvement in eventual cure rates."

Twelve tables. JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Evaluation of Failures in Treatment of Oral Cancer. Arthur G. James. Am. J. Roentgenol. **83:** 421–431, March 1960. (Ohio State University Health Center, Columbus, Ohio)

The report is an extensive and excellent analysis of 136 cases of head and neck cancer followed for five or more years and 218 cases seen three or more years after treatment. The cases were classified as to the extent of the primary carcinoma and presence and extent of metastatic involvement. In general, the lesions were treated by surgery when feasible. Those that were not surgically approachable were treated by irradiation. Radiation therapy was also used as an adjunct to surgery when complete resection was impossible.

An excellent discussion of clinical staging introduces the analytic study, which includes lesions of the anterior tongue, floor of the mouth, gingiva, buccal mucosa, and hard palate.

Review of the 91 failures in the five-year series showed that 20 per cent were not related to treatment. This group had received either palliative therapy or none at all, because of disease extension, or died of intercurrent disease, of a second primary tumor, or postoperatively. Of the remaining failures, 25 per cent were due to lack of control of the primary lesion and approximately 75 per cent to uncontrolled metastatic lesions.

Results were better in the group of cases presenting no metastases. Most of the failures were due to lack of control of the metastatic lesions.

Twenty-four tables. JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

The Private Dermatologist and Skin Cancer. A Clinical Study of Two Hundred Twenty-Six Epitheliomas Derived from Five Dermatologic Practices. Richard J. Ferrara. Arch. Dermat. **81:** 225–234, February 1960. (2023 Mack Ave., Grosse Pointe Woods 36, Mich.)

The author has analyzed the results of treatment of 226 histologically proved epitheliomas, in 186 patients, with follow-up of five years or more. These cases were derived from the private practices of five Detroit dermatologists, each of whom favored one or more acceptable methods of treatment. After five years, 206 of the 226 epitheliomas (94.5 per cent) were clinically cured. Scalpel surgery resulted in a five-year cure in 64 of 71 lesions (95.5 per cent); electrocoagulation and curettage in 74 of 82 lesions (94.9 per cent); x-ray therapy in 46 of 50 (93.9 per cent); combined electrocoagulation and surgery plus x-ray therapy in 19 of 19 (100 per cent). Cure was obtained in 1 case treated by chemosurgery and in 1 of 3 treated by radium, but these numbers are too small to be considered significant. Eleven of the epitheliomas (9 basal-cell, 2 squamous-cell) recurred. Only one death was attributed to treatment failure; this patient supposedly died of metastasis from squamous-cell carcinoma of the lower lip. Eight patients died of other causes before five years without any evidence of treatment failure. Cosmetic results were excellent in 85 lesions, good in 113, and poor in 8; there was a relatively lower percentage of excellent results with scalpel surgery.

It is concluded that no one specific therapeutic modality is optimal for all skin cancers, and in certain instances one procedure may actually be contraindicated. In general, it is not the particular method of treatment that is of greatest importance but the training, experience, and capabilities of the individual physician in its application.

Eight tables.

Cancer of the Breast: Radiation Therapy of Carcinoma of the Breast Supplementing Surgery. Galen M. Tice. J. Kansas M. Soc. **61:** 122–127, March 1960. (University of Kansas School of Medicine, Kansas City, Kans.)

During the period 1930 to 1955, radiation was given to 907 patients with primary breast carcinoma, either pre- or postoperatively or, in a few hopeless, far-advanced cases, as primary treatment. In this same period there were referred for radiotherapy 183 cases of recurrent tumor: bone or skin metastases, ascites or pleural effusion, recurrent supraclavicular or axillary node involvement, and in a few cases lung, liver, or brain metastases. There was no uniformity in the operative procedures, which were done by many different surgeons. Irradiation, even though planned and administered by one radiologist and his residents, varied with the facilities available.

For purposes of reporting, Portmann's classification was employed, as modified by Ash *et al.* (Surg., Gynec. & Obst. **96:** 509, 1953. Abst. in Radiology **62:** 469,

1954) to include all tumors 6 cm. or larger in Stage III. The five-year survival for the series was: Stages I and II, 350 of 730 patients (48 per cent); Stages III and IV, 10 of 177 patients (6 per cent). One hundred sixty-three patients (22.3 per cent) in Stages I and II survived more than ten years; 74 (10 per cent) more than fifteen; 19 (2.6 per cent) more than twenty. No patients with Stage III or IV disease were alive after ten years.

Forty patients received preoperative irradiation. Survival rates in this series were: five years, 55 per cent; ten years, 33 per cent; fifteen years, 28 per cent; twenty years, 17.5 per cent. Eighteen times the pathologist made note of "shrunken, atrophic, or unrecognizable tumor cells," and 25 reports mention hyalinization, fibrosis, or endarteritis. It would thus seem logical to make this a standard procedure.

The author points out the hazard of comparing series of cases with different plans of management and with different degrees of tumor development and spread. In assessing survival figures, many intangible factors, such as slow growth or inherent resistance, must be considered.

Six tables.

Primary Lymphosarcoma (Reticulum Cell) of the Stomach (Case Report). Gerald A. Erhard, William V. Banning, and Arnold D. Piatt. Ohio State M. J. **56:** 491–494, April 1960. (Newark Hospital, Newark, Ohio)

A case is reported of an inoperable primary lymphosarcoma of the stomach in a 75-year-old woman, treated by irradiation, with survival of five years.

Roentgen examination showed polypoid filling defects on the greater curvature of the gastric fundus and pars media that were suggestive of a tumor. Exploratory surgery revealed a large indurated, nonresectable mass involving the fundus and upper portion of the pars media with extensive lymph node involvement in the lesser omentum. Biopsy showed lymphosarcoma.

Between Sept. 2 and 12, 1953, external radiation was administered directly to the left upper abdomen through an anterior port, in fractionated doses, for a total of 600 r in air. The factors were 200 kv, filtration (inclusive of inherent) 0.75 mm. Cu, h.v.l. 1.25 mm. Cu, 15 × 15 cm. field, 50 cm. focus-skin distance. The rate of administration was 38.7 r per minute. The patient refused to return for further treatment until Oct. 30, when irradiation was resumed and continued until Nov. 18. Anterior and posterior ports of 15 × 15 cm. over the left upper epigastrium were used, alternately, and a total tumor dose of approximately 1,350 r was delivered. A satisfactory remission of symptoms was obtained.

On roentgen examination in May 1955 the stomach was within normal limits except for some puckering high in the pars media and the fundus on the greater curvature side, presumed to be due to scarring. In August 1957 the patient was readmitted to the hospital after a sudden onset of severe pain in the upper epigastrium, which responded to medical management.

The final admission was on April 25, 1958. Roentgenography showed the puckering previously observed. The C loop of the duodenum appeared slightly elevated and possibly displaced from extrinsic pressure beneath it. The clinical impression was common duct obstruction due to recurrent lymphosarcoma. Surgery was contraindicated by the poor condition of the patient, and external radiation was again given through anterior, lateral, and posterior ports of 10 × 15 cm. in rotation. The total dose, in air, to each port was 500 r. No improvement was noted, and death occurred on May 28, 1958.

At autopsy the pathological diagnoses were: Obstruction of the common duct by a gallbladder calculus at the ampulla of Vater with severe obstructive jaundice superimposed on a pre-existing atrophic nutritional cirrhosis of the liver; chronic cholecystitis and cholelithiasis; pancreatic fibrosis; pericholecystic adhesions; irregular atrophy and scarring of the gastric wall mucosa on the greater curvature. There was no evidence of lymphosarcoma.

Four roentgenograms; 4 photomicrographs.

Retroperitoneal Tumours. I. G. Williams. Clin. Radiol. (J. Fac. Radiologists) **11:** 80–82, April 1960. (St. Bartholomew's Hospital, London, England)

The term "retroperitoneal tumor" as used by the author excludes primary tumors of the pancreas, adrenals, and kidneys. His classification includes (1) primary, (2) secondary, and (3) lymph node involvement in the course of one of the malignant reticuloses.

Primary retroperitoneal tumors are rare; they may be congenital, as Wilms' tumor and neuroblastoma, or they may be acquired. The latter include sarcomas, which originate from the various types of connective tissue. If a tumor is not definitely palpable, clinical diagnosis is often a suspicion. X-ray examination may be most helpful. The importance of laparotomy for establishing the diagnosis and determining the extent of the growth is emphasized. In the majority of cases the tumor is not removable. In this event, curative or palliative irradiation, as indicated, becomes the mainstay of treatment.

Patients with secondary tumors in para-aortic or retroperitoneal lymph nodes should also be subjected to laparotomy, solely for the purpose of obtaining tissue for histologic examination. In some cases the primary site is not known. From a radiotherapeutic point of view, the most important tumor in this group is seminoma of the testicle, since complete regression and long survival may be obtained, even in the presence of a large neoplasm.

The commonest of the malignant reticuloses is Hodgkin's disease. While the patient may have an abdominal tumor, the only clinical manifestation may be fever and/or pruritus. Again the importance of laparotomy is emphasized. The author and his associates have recently been using a combination of nitrogen mustard and x-ray therapy. The nitrogen mustard is given in a single large intravenous injection. A sedative accompanies the administration of 0.2 to 0.4 mg. per kg. body weight. X-ray therapy is started immediately, and given in the same manner as if no nitrogen mustard had been employed. It is too early for discussion of results. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Remission of Graves' Disease Following Radiotherapy of a Pituitary Neoplasm. Joseph W. Jailer and Donald A. Holub. Am. J. Med. **28:** 497–500, March 1960. (Presbyterian Hospital, New York 32, N.Y.)

A 51-year-old woman with thyrotoxicosis and unilateral exophthalmos was found also to have an expanding lesion of the pituitary gland, which was

thought to have a possible etiologic role in the Graves' disease. Accordingly, it was elected to irradiate the pituitary tumor and to observe the patient closely for evidence of remission of the thyroid disease. A tumor dose of 3,560 r was delivered through three well shielded ports over a five-week period. Otherwise no antithyroid measures were employed. Convincing clinical remission of the patient's hyperthyroidism occurred, and within three weeks of completion of the course of radiotherapy she had gained 18 pounds. After seven months, the results of thyroid function tests were within the normal range. It is postulated that the pituitary tumor in this patient produced excessive quantities of TSH (thyroid-stimulating hormone) and so was directly responsible for the thyrotoxicosis.

The case reported probably represents an example of thyrotoxicosis with noninfiltrative exophthalmos to which a definite etiology can be ascribed, *i.e.*, a pituitary tumor producing excessive amounts of TSH. Extrapolations from this case to the etiology of Graves' disease in general are unwarranted and unwise.

One roentgenogram.

The Bioassay of Host Radiosensitivity. An Index of Radiocurability Applied to Cervical Carcinoma. Hugh James Davis, Howard W. Jones, Jr., and Robert J. Dickson. Cancer **13:** 358–361, March-April 1960. (H. W. J., Johns Hopkins University School of Medicine, Baltimore, Md.)

Previous investigators, including the Grahams, have suggested a relationship between radiation injury to normal tissues and radiocurability of cervical carcinoma. This report concerns a quantitative technic for the bioassay of host radiosensitivity: The tests were made on the buccal mucosa of 64 women with carcinoma of the cervix; the minimum follow-up was two years.

A single dose of 1,500 r in air was delivered to the buccal mucosa just inside the mouth through a 3-cm. cone, at 100 kv, h.v.l. 1.3 mm. Al. Smears were obtained on alternate days for a three-week period, and studied for macrocytosis and multinucleation. Rigid criteria were employed, with only solitary cells counted, the first to appear in a field and only one cell in a given field.

Although both determinations correlated with radiocurability, the multinuclear counts were more rapid, more reproducible, and more accurate prognostically. If the exfoliation of 9 per cent or more multinucleate buccal cells is selected as a good response for Stage 1 carcinoma of the cervix, while a value of 12 per cent or more is set for Stage 2, the buccal radiation-tolerance test correlated with end-results in 44 of 50 patients. The prognostic error in this preliminary series was therefore 12 per cent in those cases most amenable to alternative surgical management.

A not unexpected finding was the suggestion that a somewhat greater degree of radiosensitivity is requisite to insure radiocurability as the carcinoma advances in lateral extension. The survivors with Stage 3 cervical carcinoma showed multinucleate counts of 17 per cent or more.

Metabolic disturbances, malnutrition, and anemia are known to alter sensitivity, but it seemed unlikely that such factors were primarily responsible for the differences reported. The authors tested a considerable number of patients retrospectively, as long as ten to fifteen years after their original therapy for cervical carcinoma, demonstrating good responses. Several patients were also retested by use of the contralateral check after a lapse of as long as two years and the response pattern remained unaltered.

The remarkable parallelism noted in this series between radiation-induced multinucleation in buccal epithelial cells and radiocurability of cervical carcinoma may well be explained as due to a common genetic nuclear matrix of the normal and malignant cells in a given individual.

Six graphs. CHARLES M. GREENWALD, M.D.
St. Cloud, Minn.

Some Clinical Aspects of Megavoltage. Seminoma of the Testis. Robert Gibb. Proc. Roy. Soc. Med. **53:** 235–238, April 1960. (Christie Hospital, Manchester, England)

This and the three following papers (see succeeding abstracts) are concerned with the clinical experience at the Christie Hospital (Manchester, England) since 1955 with their 4-Mev linear accelerator in the management of certain malignant conditions. Gibb summarizes the principles which have been accepted for the prophylactic treatment of seminoma of the testis following orchiectomy: (1) The irradiated volume must include the scrotum and the inguinal, iliac, and para-aortic lymph node areas, and the abdomen to the level of the diaphragm. (2) The volume to be treated should be irradiated in one block, without the need for matching field edges. (3) Irradiation should be as homogeneous as possible.

After orchiectomy, intravenous urography is performed, and the position of the kidneys marked on the patient's skin. An irregular treatment field is then laid out to allow complete shielding of the kidneys and yet to include a large volume of the trunk. The upper margin of the anterior field is at the level of the xiphisternum, allowing a generous clearance of the upper para-aortic nodes, the iliac nodes, and the greater part of the inguinal lymph node area. The lower edge is at the perineum. A replica of the anterior field is drawn on the back of the patient. The usual size of the irradiated area is 800–900 sq. cm., achieved with focal skin distance of 130–150 cm. The tumor dose is 3,000 rads in four weeks, with treatment five days a week, alternately to anterior and posterior fields.

When known metastatic disease is present in the abdomen when the patient is first seen, shielding of the kidneys frequently is not practical and the risk of radiation damage to the kidneys must be accepted. Patients with lung metastases but without abdominal metastases are treated with similar, roughly rectangular fields, with lungs, mediastinum, and supraclavicular fossae included in the treated volume. The tumor dose is 2,500 rads in four weeks.

Of 12 patients with abdominal and lung metastases, none survived for a reasonable length of time considering the very prolonged treatment. There is only one long-term survivor.

The author feels that 4-Mev radiation has simplified the technic of treating the abdomen and the chest in seminoma. The patients seem to have "an easier time" with megavoltage therapy than with similar doses with 250-kv radiation. The incidence of radiation sickness and bowel reactions does not appear to differ significantly with the two technics.

One roentgenogram; 1 photograph; 4 diagrams.
JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Some Clinical Aspects of Megavoltage. A Wedge Filter Approach with 4 MV Radiation to the Treatment of Carcinoma of the Alveolus and Antrum. J. G. Stewart. Proc. Roy. Soc. Med. **53:** 239–242, April 1960. (Christie Hospital, Manchester, England)

The author gives an account of experience in the use of wedge filters with 4-Mev radiation in treatment of cancer of the lower alveolus and of the antrum and accessory sinuses.

The relative absence of lateral scatter with 4-Mev radiation results in a more or less direct relationship between the dose at a point and the intensity of the primary beam through that point. Consequently, attenuation of the primary beam, as by a wedge filter, is reflected accurately by the isodose curves. The wedge angulation is thus maintained into depth.

In the conventional treatment of tumors around the mouth, three plain fields arranged symmetrically around the head are necessary to secure homogeneity and localization. With the increased penetration at 4 Mev, exactly the same conditions can be achieved with only two wedged fields. Even so, for centrally placed tumors, wedge-filter therapy can claim no advantage over cross-fire therapy with plain fields. For peripherally placed tumors, however, wedge therapy is of considerable advantage both in simplicity of prescription and in economy of radiation to normal tissues.

Three wedges of different slopes—40, 50, and 60°—are employed. The use of a variety of wedge angles facilitates the matching of the high-dose zone to the tumor shape. The author states that "so sharp is the fall-off at the edge of the treated zone that localization of the tumor must be exact, if it is not to be missed." Inactive radon seeds are implanted as markers wherever possible and, following preparation of a plastic beam direction shell, localization is verified radiologically.

Lesions of the Lower Alveolus: For tumors of the lower alveolus, an efficient prescription pattern can be set up, using two fields. Recommended placement of the fields and their sizes are indicated by diagrams. Tumor doses have recently been increased from 5,000–5,600 rads in three weeks to 6,000 rads in three weeks, without unduly severe reactions.

Lesions of the Antrum and Accessory Sinuses: For lesions below the roof of the antrum, a wedge pair from front and side gives adequate coverage. Where the orbit, ethmoid cells, or frontal sinuses are also involved, special measures must be utilized to spare the eye on the sound side and, as much as possible, the eye on the diseased side. These technics are demonstrated in detail and suitable diagrams are presented. A commendable feature is that the depth-dose at 4 Mev is relatively independent of area, and odd-shaped fields are thus permissible. Current practice is to deliver 6,000 rads in three weeks if the treated volume is less than a 7-cm. cube. If the treated volume must be larger, 5,500 rads or slightly less is given in three weeks.

Results: A comparison of the results with radical 4-Mev wedge therapy and the overall results at the same institution in an earlier period, before the use of megavoltage, suggests a little improvement in survival rate and in the figures for primary recurrence.

The author concludes "wedge filter techniques with 4-Mv radiation offer a precision and elegance of prescription hitherto not available. In consequence reactions are more localized and treatment more easily tolerated. . . .It is hoped that, given optimum dosage, increased proficiency of technique afforded by wedge filter therapy will express itself in the form of better results."

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Some Clinical Aspects of Megavoltage. The Treatment of Carcinoma of the Middle Ear by the 4 MV Linear Accelerator. K. S. Holmes. Proc. Roy. Soc. Med. **53:** 242–244, April 1960. (Christie Hospital, Manchester, England)

Early experiences with the treatment of carcinoma of the middle ear with the 4-Mev linear accelerator are reviewed.

The technic of treatment by means of the linear accelerator remains essentially unchanged from that employed with beam-directed x-rays at conventional levels. In the majority of cases it is impossible to localize the tumor with exactitude, particularly as the spread in bone may not be apparent roentgenographically; chronic middle-ear infections may also obscure the roentgen picture. For this reason, the treated volume must be larger than at first may seem necessary. A Perspex shell is fitted to the patient's head. The volume to be treated is chosen and localized radiographically. Three fields have been found to give an ideal dose distribution. A homolateral field directed along the axis of the petrous portion of the temporal bone is balanced by contralateral and submandibular and temporal fields. Such an arrangement includes the whole petrosa in the treated volume while sparing the midbrain. Field sizes vary, but usually are of the order of a 6-cm. circle. A calculated tumor dose of 5,000 to 5,500 rads is delivered in three weeks.

Of 22 patients treated by the above method, 77 per cent have survived two years or more. In an attempt to assess the significance of these figures, the author reviewed the statistical data from 115 histologically proved cases of carcinoma of the middle ear, seen at the same institution between 1932 and 1958; 48 of these were treated radically, by beam-directed x-rays or the radium beam. In the radically treated groups, there was a difference of only 6 per cent between the two- and five-year survivals, and there is no reason to think that the pattern of survival will change with the new treatment. Although the composition of the premegavoltage and megavoltage groups was similar, only 35 per cent of the patients receiving radical radium or x-ray therapy were alive at the end of two years while 77 per cent of the 4-Mev group survived. Further analysis shows that the results with teleradium therapy were much better than those with beam-directed x-rays.

The author concludes that already strong evidence is at hand that the treatment of carcinoma of the middle ear by the 4-Mev linear accelerator does represent a significant advance over other methods.

Six tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Some Clinical Aspects of Megavoltage. Bladder Carcinoma. R. C. S. Pointon. Proc. Roy. Soc. Med. **53:** 244–246, April 1960. (Christie Hospital, Manchester, England)

A report is made of two years experience in the treatment of carcinoma of the bladder with the 4-Mev linear accelerator. Criteria for selection of patients for treatment were strictly followed. All early bladder tumors,

i.e., mucosal and muscular tumors up to 4 cm. in diameter, were treated by permanent radon seed implants. Metastatic tumors and tumors with gross pelvic fixation were treated palliatively. The remainder, including multiple mucosal tumors, were treated radically, provided the patient's general condition was adequate.

The principle of small-volume high-dose was adhered to. Field sizes used were 8 × 6 cm. or the equivalent area for small lesions and 10 × 8 cm. or equivalent area for larger lesions. Accurate localization of the tumor is essential, and was based upon cystoscopic examination under anesthesia and cystograms. Beam direction was determined by a modified pin-and-arc method. Tumor doses of 6,000 rads in three weeks were delivered to fields up to 50 sq. cm., and 5,500 rads in three weeks to areas up to 80 sq. cm.

For the 87 patients treated with the linear accelerator, a crude three-year survival of 29 per cent was obtained. Symptoms due to bladder reactions were not severe. Rectal reactions were more noticeable, particularly in patients whose tumors were on the posterior bladder wall in close proximity to the rectum. Only 1 instance of serious large bowel injury was encountered, and this case is reported in detail. A comparison of the results in this group of patients with those in an earlier group treated by 500-kv radiation showed that the three-year survival rate was essentially the same—29 per cent for 87 patients treated by megavoltage and 27 per cent for 97 cases treated by 500-kv. It is the author's impression that the bladder reactions were about the same in the two groups, but that the rectal reactions were less severe with megavoltage therapy.

If one accepts a relative biological effect of 85 per cent for megavoltage radiation, then the radical therapy tumor dose should be increased to 6,500 rads for fields up to 50 sq. cm. and 6,000 rads for the large fields, in three weeks. Since 1957 these dosages have been employed, with no noticeable increase in the severity of reactions; no significant complications have occurred. At present a study is under way to compare direct clinical results and side reactions in parallel series of patients, one group receiving 500-kv radiation and the other 4-Mev radiation.

One graph; 2 tables. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Carcinoma of the Bladder: Its Treatment by Supervoltage X-Ray Therapy. Robert Morrison. Clin. Radiol. (J. Fac. Radiologists) **11:** 125–129, April 1960. (Hammersmith Hospital, London, England)

Between 1954 and 1958, 210 patients with cancer of the bladder were treated with an 8-Mev linear accelerator at the Hammersmith Hospital, London (England). The features of the disease which have a bearing on treatment are reviewed; these include the behavior and the spread of the tumor; its sensitivity to radiation and the chance of tumor ablation with the dose prescribed; and the effect of the tumor on the bladder and kidney function.

If it was felt that the tumor had not invaded the extravesical tissues, only the bladder and a small surrounding margin of tissue were treated. With palpable extravesical extension, larger fields were employed so as to include the whole anterior part of the pelvic cavity and the lymph nodes on the lateral pelvic wall.

Treatment was given by a fixed field technic, with the common arrangement of four obliquely directed fields. An average field size for an intravesical tumor was 7 × 9 cm.; for tumors which had spread outside the bladder, about 10 × 10 cm. Treatments were scheduled daily, up to a total of 5,500 rads in four weeks for intravesical tumors and up to 4,500 rads for those with extravesical extension.

Because of postural and individual variation in the position of the bladder, it was found necessary before treatment to obtain radiographs of each field with the bladder opacified.

Management of the patient included especial attention to anemia and urinary tract infection. Kidney function was checked with blood urea determinations. A low residue diet was prescribed, and hydrocortisone rectal suppositories were employed to combat the radiation reaction of the intestinal tract.

Hematuria, which is the commonest symptom of bladder cancer, was usually arrested during the third week of treatment, *i.e.*, by the time the tumor had received 2,500 rads. The two-year survival rate for the 210 patients in the present series was 35 per cent; for the 96 with intravesical tumors the two-year survival rate was 44 per cent and for the 114 patients with extravesical tumors, it was 26 per cent. The two-year survival rate of 35 per cent is similar to that obtained in other series with total cystectomy. The patients suitable for cystectomy, however, are more highly selected than those given radiotherapy; in the latter group are included patients with advanced disease and those in a condition unsuitable for surgery. When not curative, radiotherapy may produce relief of symptoms for long periods.

Bladder contraction and telangiectasia after irradiation are mentioned, but the author does not give the incidence in his series.

Two diagrams; 3 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Application of Television in Supervoltage Therapy. F. K. Baum and H. Kuttig. Atompraxis **6:** 97–99, 1960. (In German) (Czerny-Krankenhaus für Strahlenbehandlung, Universität Heidelberg, Germany)

In supervoltage and radiocobalt therapy, proper protection of the personnel in the adjacent control room deserves most serious consideration. The lead glass window, necessary for continuous observation of the patient, has to be extremely thick and entails considerable expense. To meet this situation, a television system was installed in the Czerny Hospital for Radiotherapy, at Heidelberg. Its satisfactory performance over the subsequent eighteen months is herewith reported.

The camera in the treatment room is easily adjustable and allows a wide variety of views of the patient and the equipment. The television screen is mounted directly above the control stand. Thus, the technician can observe the patient, controls, and meters simultaneously. Best of all, the control room need no longer be adjacent to the treatment room. The further away it is, the more protection is available for the operator.

In view of its advantages, a television system is highly recommended in supervoltage and telegammaray installations.

Two photographs. ERNEST KRAFT, M.D.
Northport, N. Y.

RADIOISOTOPES

Radioiodine Tracer Tests in the Evaluation of Thyroid Function. Results of 6-Hour and 24-Hour Uptake Determinations in 357 Patients. Jesse D. Ibarra, Jr., John Q. Thompson, John S. Alexander, and Zoltan Petrany. Am. J. M. Sc. **239:** 140–143, February 1960. (Scott and White Clinic, Temple, Texas)

To determine the optimum time for measuring the percentage of a tracer dose of radioiodine collected by the thyroid gland, 357 patients had uptake determinations at six and at twenty-four hours. After careful clinical and laboratory correlation, 214 patients were found to be clinically euthyroid, 41 had hypothyroidism, and 102 revealed hyperthyroidism. When the radioiodine uptake tests were made at six hours, the normal and hypothyroid ranges overlapped significantly. The twenty-four-hour uptake showed a smaller percentage of patients with overlapping values and, therefore, determinations made at this time were considered more reliable for diagnosing hypothyroid disease. The euthyroid and hyperthyroid ranges did not overlap when the uptake determinations were made at six hours or at twenty-four hours, but the separation of the normal and the hyperthyroid ranges was greater when the uptakes were determined at six hours.

From this study, it was concluded that a determination for radioiodine uptake at twenty-four hours is more reliable than one at six hours for distinguishing hypothyroidism from euthyroidism, whereas an uptake determination at six hours seems sufficient for distinguishing hyperthyroidism from euthyroidism. When feasible, however, radioiodine tracer tests performed at both six and twenty-four hours will serve to evaluate thyroid function better than a single measurement at either interval.

Two figures; 3 tables. W. H. CARROLL, M.D.
Shreveport, La.

Diagnostic Limits for Thyroidal Radioiodine Uptake Rates. T. H. Oddie, I. D. Thomas, F. F. Rundle, J. Myhill, and B. Catt. J. Clin. Endocrinol. **20:** 389–400, March 1960. (Royal North Shore Hospital of Sydney, Crows Nest, N.S.W., Australia)

The thyroidal I^{131} uptake was measured in 1,116 Australian subjects, who had received no prior thyroid-affecting medication. The object of the investigation was to define the diagnostic ranges for the local population and to describe the observed differences between persons of different sexes and age groups. The logarithm of the uptake rate factor for various functional groups was found to be normally distributed. Diagnostic borderlines are described for premenopausal and postmenopausal females with and without goiter, and for males with and without goiter. The I^{131} uptake rate was found to decrease progressively with age in males. In females it remained constant until the age of the menopause, following which a progressive decrease was seen. In 76 per cent of the subjects a clear diagnosis was established by a single thyroidal I^{131} uptake test.

The average normal values for the thyroidal I^{131} uptake rate obtained in this study are greater than the normal values described previously (J. Clin. Invest. **34:** 95, 106, and 1044, 1955) for a different population, by a factor of 3.6. There is no evidence that the output of hormone by the thyroid gland in Australia is greater than that in Britain or the United States of America, and it appears likely that this higher uptake rate reflects a state of relative iodine deficiency of the thyroid, secondary to a smaller iodide pool associated with iodine-deficient food intake or possibly to the chronic ingestion of naturally occurring goitrogens.

Five figures; 5 tables.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

The Effects of Several Thyroxine Analogues Upon the Thyroidal I^{131} Uptake in Man. Stanley Slater, Martin Perlmutter, Julio Paz-Carranza, and Marvin Numeroff. J. Clin. Endocrinol. **20:** 401–408, March 1960. (Maimonides Hospital, Brooklyn, N. Y.)

The 24-hour thyroidal radioiodine uptake was determined in a group of euthyroid and hyperthyroid human subjects before and after the administration of one of several analogues of thyroxine. The analogues used were 3,5,3′-*l*-triiodothyronine (3′-T_3); 3,3′,5′-*dl*-triiodothyronine (5′-T_3); 3,5,3′-triiodothyroacetic acid (Triac); 3,5,3′,5′-tetraiodothyroacetic acid (Tetrac); 3,5,3′-triiodothyropropionic acid (Trip). The minimal dose of each analogue which was effective in inhibiting thyroidal I^{131} uptake in the euthyroid subjects was ascertained. If 3′-T_3 is assigned a potency of 100, the potencies of the other analogues as determined in this manner were: 5′-T_3, < 1; Triac, 2.4; Tetrac, 5; and Trip, 2.5.

These projected potencies were compared with those derived by other investigators, with the use of different technics in several species of animals in addition to man. In the present series, with the dosages employed, these analogues had no effect upon thyroidal I^{131} uptake in any of the hyperthyroid subjects.

Three tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

The Effects of Certain Physical and Emotional Tensions and Strains on Fluctuations in the Level of Serum Protein-Bound Iodine. Robert Volpé, Joan Vale, and MacAllister W. Johnston. J. Clin. Endocrinol. **20:** 415–428, March 1960. (University of Toronto, Toronto, Ont., Canada)

The effect of physical and emotional tensions and strains on the fluctuation of the serum protein-bound iodine level was studied, following tracer doses of I^{131}, in groups of healthy persons and in two groups of patients. The effect of the tension and strain of examination was observed in 11 medical students preparing for annual examination and in 11 Royal College of Physicians candidates. The stress of athletic contest on the protein-bound iodine level was observed in 7 professional football players in training and during their scheduled games. In none of these groups was there a fluctuation beyond that found in a normal control group not under any special stress. Similarly, in 8 patients prior to and following major operations and in 9 patients following myocardial infarction, the fluctuations of the serum protein-bound iodine level remained within the usual normal range. The authors' data fail to provide any evidence that the function of the normal thyroid gland is readily affected by severe mental and physical stresses or strains.

Eight tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Radioactive Iodine Studies in the Diagnosis of Hashimoto's Thyroiditis. I. P. C. Murray and E. M. McGirr. Brit. M. J. **1**: 838–841, March 19, 1960. (Royal Infirmary, Glasgow, Scotland)

Radioactive iodine studies were made in 41 patients with proved Hashimoto's disease, of whom 23 were hypothyroid and 18 were euthyroid. Results of thyroid uptake tests and serum PBI^{131} determinations were often anomalous and proved more useful when considered in conjunction than singly. An elevated PBI^{131} with a low uptake of I^{131} (5 cases) or with a normal uptake (17 cases) should suggest the possibility of Hashimoto's thyroiditis. When both the serum PBI^{131} and the thyroid uptake of I^{131} are raised, as in 2 of the authors' cases, distinction from thyrotoxicosis may be achieved by the thyroxine-suppression test. Similar unusual combinations of results may occur in patients who have received previous antithyroid therapy, in carcinoma of the thyroid, in sporadic goitrous cretinism, and in some cases of sporadic goiter. Scanning of the thyroid may help to differentiate between Hashimoto's thyroiditis and neoplasm. The isotope distribution is uniform in the former and usually unequal in carcinoma.

The raised serum PBI^{131} may be due in part to the presence of an abnormal iodinated protein in the blood and in part to the unusually rapid production and discharge of hormone from a gland with a low iodine pool. The observation of the effect of potassium perchlorate, which results in an appreciable discharge of the thyroid I^{131} content in cases of Hashimoto's thyroiditis, is a useful additional diagnostic aid.

Four figures; 1 table.

Varying Responses to Radioactive Iodine (I^{131}) Therapy in Hyperthyroid Patients. Melvin D. Cheitlin, Robert Bernstein, and Edward A. Langdon. Ann. Int. Med. **52**: 349–361, February 1960. (Walter Reed Army Hospital, Washington 12, D.C.)

One of the perplexing problems in the therapeutic use of radioactive iodine in hyperthyroidism is the calculation of dosage. In an attempt to reduce the incidence of overtreatment, the authors give the smallest dose of I^{131} which they believe will render the patient euthyroid. This is calculated as 100 μc/gm. of estimated weight of the thyroid gland. The patient is re-evaluated periodically and, if toxicity persists, further treatment is given, with calculation of the dose in a similar way.

The response to any treatment is individual. It has been suggested by some that if the protein-bound iodine determination or the I^{131} uptake remains elevated one to two months after treatment, further therapy will probably be necessary. Clinical abstracts of 14 cases illustrate the variability of response to treatment and the difficulty in predicting the ultimate outcome on the basis of short-term laboratory or clinical follow-up. These cases were selected from a series of hyperthyroid patients treated with radioactive iodine at Walter Reed Army Hospital in the last eight years.

In the great majority of cases a dose of radioactive iodine, calculated at 100 μc/gm. of weight of the thyroid gland, will produce the desired result of euthyroidism within a period of three months. The actual calculation of the dose in an individual patient is made according to the formula proposed by Quimby *et al.* (Nucleonics **2**: 56, April 1948; **2**: 44, May 1948)

With the dose thus calculated, the authors attempt to deliver 7,000 to 10,000 rep to the thyroid gland. There are assumptions in this formula, however, which are known to be inaccurate. One must therefore keep in mind the following factors which can alter the expected final outcome: (1) There is no way of determining accurately the actual size and weight of the gland. (2) The radioactive iodine is not distributed uniformly throughout the gland. (3) The amount of radioactive iodine in the thyroid at any one time depends upon the balance between the uptake of I^{131} by the gland and its excretion from the gland. The rate of this turnover varies from patient to patient. (4) It is probable that sensitivity of thyroid tissue to the action of radioactive iodine varies.

Clinical benefit is usually seen within one month following therapy. Until this effect is achieved, most patients can be maintained in relative comfort with ataraxia and sedation. If at all possible, thiouracil derivatives and stable iodine are avoided for at least three weeks to one month, because these substances interfere with recirculation of radioactive iodine through the gland.

As shown by 5 of the authors' cases, the various laboratory tests of thyroid function, such as the determination of protein-bound iodine and I^{131} uptake, can remain abnormally elevated for many months after treatment and then return to normal. The significant point is that in each of these cases the patient showed clinical improvement and further definitive therapy was withheld.

One fact occasionally overlooked is that for several months after radioactive iodine therapy, the I^{131} uptake and even the protein-bound iodine determination can be in the hypothyroid range before returning to normal limits. Other patients, after radioactive iodine or subtotal thyroidectomy, become euthyroid, only to have hypothyroidism develop gradually at some later date. The period of euthyroidism may last for several years.

STEPHEN N TAGER, M.D.
Evansville, Ind.

Serious Thyrotoxic Crisis After Therapeutic Dose of I^{131}. H. Goldschlag. Schweiz. med. Wchnschr. **90**: 320–321, March 12, 1960. (In French) (Clinique universitaire de médecine interne, Geneva, Switzerland)

The author reports the case of a 45-year-old female who experienced a life-threatening "thyroid storm" twenty-four hours after receiving a therapeutic dose of 5 millicuries of I^{131}. Essential features were: difficulty in swallowing, intractable vomiting, a state of confusion and delirium, and acute myopathy. The crisis was brought under control by antithyroid drugs and iodine.

The author proposes prophylactic antithyroid therapy in addition to radioactive iodine treatment of hyperthyroidism.

RENÉ HOURI, M.D.
New York, N. Y.

Leukaemia After I^{131} Therapy for Thyroid Cancer. A. M. Jelliffe and K. M. Jones. Clin. Radiol. (J. Fac. Radiologists) **11**: 134–135, April 1960. (Middlesex Hospital, London, W.1, England)

The occurrence of acute myeloid leukemia after the administration of large doses of radioiodine for thyroid cancer is now well documented. The authors report a new case which developed after a total dose of only 400 mc of I^{131}.

A 74-year-old woman was first seen with a pathological fracture through an area of bone destruction in the upper femur, which biopsy revealed to be a metastatic deposit from an adenocarcinoma of the thyroid. The

patient also had pulmonary and mediastinal tumor deposits, all of which showed good I^{131} uptake. Two doses of 200 mc of radioiodine were given three months apart, and the patient had a good remission until she became leukemic, two years after the administration of the isotope.

While recognizing that acute leukemia is a risk which has to be accepted in treating thyroid cancer with I^{131}, the authors are disturbed at its development after the relatively small doses which their patient received. The desirability of ablating the thyroid surgically when possible is stressed.

Since some thyroid cancers are of an extremely low grade of malignancy, long-term remissions can sometimes be induced by suppressive doses of thyroid, thyroxine, or tri-iodothyronine. This form of therapy should not reduce the chances of a response to I^{131} at a later date.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Radioactive Phosphorus in the in Vivo Diagnosis of Melanoma of the Skin. Earle W. Brauer, Alfred W. Kopf, Victor H. Witten, Mones Berman, and Vernal G. Cave. J.A.M.A. **172:** 1753–1758, April 16, 1960. (40 Journal Sq., New York, N. Y.)

The need for a dependable *in vivo* method for accurately differentiating between pigmented malignant melanoma and pigmented benign lesions resembling melanoma prompted an investigation of the possibility of using radioactive phosphorus for this purpose. Forty-nine patients suspected of having melanoma or some condition likely to be confused with it were chosen for the study. Similar studies were performed in a wide variety of lesions, including hemangiomas, granulation tissue, and various benign and malignant tumors.

"Background" counts were taken over the lesion in question and over an area of normal skin on the contralateral side, to serve as a control. All counts were made with a thin end-window Geiger-Müller probe covered with a thin sheet of polyester film and brought into contact with the skin. To limit the survey to the immediate tumor area, adapter shields made of Lucite were used over the end-window of the probe and against the skin. Each patient was given 150 μc of P^{32} in 10 c.c. aqueous solution intravenously. Many readings were then made over the lesion and the control area, usually at three- to ten-minute intervals at first and less frequently as the counts began to stabilize or diminish. For each patient the resulting data were plotted on graphs, and statistical analyses were made. The results were expressed as a ratio—the number of counts per minute over the tumor site to the counts per minute over the contralateral normal skin control site. Two illustrative cases are presented. In the first the results of the test were positive and the lesion proved to be a melanoma; in the second the results suggested a melanoma but histologic examination of the excised tumor revealed a benign sclerosing hemangioma.

The authors were able to confirm the findings of others that there is a higher ratio of radioactivity at the tumor site as compared to normal skin for the proved cutaneous melanomas taken "as a group" than there is for other lesions. However, among the 145 skin lesions studied by this method, many false-positive results (20 per cent), in lesions which were not cutaneous melanomas, and many false-negative results (73 per cent), in proved melanomas, were obtained (if one accepts ratios of surface radioactivity (tumor/control) as low as 1.3 as diagnostic of melanoma). The radiophosphorus method, therefore, cannot be depended on in isolated instances to differentiate *in vivo* between cutaneous melanoma and clinically similar lesions. It is felt, however, that in a large series of cases, if the results of this test were coupled with all available clinical information short of biopsy, an overall improvement in the accuracy of clinical diagnosis might be attained.

Three photographs; 1 chart; 3 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Incidence of Leukaemia in Patients with Polycythaemia Vera Treated by ^{32}P. E. M. Le..ie. Clin. Radiol. (J. Fac. Radiologists) **11:** 130-133, April 1960. (Royal Marsden Hospital, London, S. W. 3, England)

Radioactive phosphorus has been used in the treatment of 117 patients with polycythemia vera at the Royal Marsden Hospital (London) since 1948. Twenty-one of this number have died. Five patients died with acute myeloid leukemia between two and a half and four years after the treatment with P^{32}. All 5 had severe polycythemia; all had initial white cell counts of over 10,000. Four of the 5 had splenomegaly, but only 1 had immature cells in the peripheral blood before the onset of the terminal leukemia. These cases are reported briefly.

In 1 woman chronic myeloid leukemia developed two years after treatment with P^{32}; she died four years later from another cause.

It is extremely difficult to assess the leukemogenic effect of P^{32}. It may be that it prolongs the life span in susceptible individuals until leukemia supervenes as the natural termination of the disease. Only rarely, however, has acute leukemia been described in polycythemia treated by other methods. Conversely, P^{32}, when employed in other diseases such as carcinoma and lymphomata, has not been observed to have a leukemogenic effect.

Despite a possible leukemogenic action, it is felt that P^{32} is still the treatment of choice for polycythemia vera.

Six figures; 2 tables. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

The Isotopic Renogram. Method, Quantitative Analysis, and Clinical Usefulness. H. W. Roth, H. Movarrekhi, and P. Wenger. Schweiz. med. Wchnschr. **90:** 286–292, March 12, 1960. (In French) (Institut du radium, Geneva, Switzerland)

The isotopic renogram is a relatively new means of evaluating renal functions. The authors describe the usual technics in detail as well as their personal modifications. Normal and pathological "renal curves" are presented and their qualitative interpretation evaluated. A mathematical method of quantitative appraisal of the curves is described and comparative tables for normal and pathological values are given.

The authors report 90 cases investigated with labeled Diodrast and stress the point that this method is more reliable than many other functional tests, especially in cases of unilateral kidney disease.

Nine figures, including 2 roentgenograms; 5 tables.

RENÉ HOURI, M.D.
New York, N. Y.

Treatment of Pleural and Peritoneal Carcinomatous Effusions with Radioactive Gold (1956–1959). Poul Bjerre Hansen and Agner Haug. Acta radiol. **53:** 321–328, April 1960. (Radium Centre for Jutland, University of Aarhus, Denmark)

Radioactive colloidal gold has been employed by the authors in the treatment of carcinomatous effusions in 87 patients (137 treatments) over a four-year period. For the pleural effusions, the average dose was 50 mc of Au^{198} and in peritoneal effusions, 150 mc. The first step in the administration of the gold was laparocentesis or thoracocentesis. To insure uniform distribution of the radiogold throughout the cavity, the patient was required to change position frequently during the first few hours. Uniform distribution was obtained in approximately 95 per cent of the cases, as determined by a gamma survey meter and scintillation scanning.

Palliative results were classed as good in 40 per cent of the series, and moderate in 20 per cent. Radioactive gold therapy seemed particularly effective in effusions originating from carcinoma of the ovary or breast, with good palliation in approximately 70 per cent of the cases. Very good results were obtained in 5 of 8 patients with primary tumors of the pleura.

Side reactions were minimal, consisting mainly of slight nausea and loss of appetite. One patient was allergic to gold, and a generalized skin rash, fever, and edema of the face developed; this subsided in two to three days.

Two to four treatments, at intervals of four to six weeks, were administered in some patients. It is the authors' impression that the beneficial effect of radiogold may be intensified, and perhaps prolonged, by repeated infusions.

The authors state that radiogold therapy is contraindicated in patients whose general condition is very poor, in cases in which the serous cavity is the site of large solid tumors, and when the cavity is divided by adhesions or bands of tumor tissue so that the radioactive material becomes trapped rather than being uniformly distributed.

Two tables.

BYRON G. BROGDON, M.D.
University of Florida, Gainesville, Fla.

Isotope $Chromium^{51}$: The Evaluation of Selected Anemias with Radioactive Material. John H. Wineinger, Sloan J. Wilson, and William E. Larsen. J. Kansas M. Soc. **61:** 145–150, March 1960. (University of Kansas School of Medicine, Kansas City, Kans.)

Radioactive chromium (Cr^{51}) is useful for tagging red cells. Once the tagged cell is destroyed by the body, the Cr^{51} is excreted in the urine and is not metabolically utilized. This fact is valuable in determining blood volume, red-cell survival in normal subjects and in suspected hemolytic disorders, and the sites of red-cell sequestration. In general, more exact information as to cell destruction is obtainable than is provided by the usual laboratory tests for hemolysis, which are of an indirect nature. Either the patient's own cells or normal donor cells may be tagged for observation of the rate of destruction *in vivo*. The important consideration is to demonstrate that the spleen is the site of active red-cell sequestration. If it is, and the red-cell survival is shortened, splenectomy is recommended.

In the present study, the red-cell survival was observed in 20 selected patients, in 18 of whom there was either moderate or severe anemia. There were 5 cases of idiopathic acquired hemolytic anemia and in all but 1 of these the red-cell survival studies could be correlated with the more commonly used laboratory procedures. An example of body scanning is presented to show determination of the sites of red-cell sequestration and evaluation of the data in predicting the effect of splenectomy.

The authors conclude that the chromium studies have made it obvious that many unexplained anemias may be of a hemolytic type. Hemolysis which may not be clinically evident when the destruction rate is only moderately increased is best demonstrated by red-cell survival studies.

Five figures; 1 table.

The Pattern of Erythrocyte Destruction in Haemolytic Anemia, as Studied with Radioactive Chromium. S. M. Lewis, L. Szur, and J. V. Dacie. Brit. J. Haematol. **6:** 122–139, April 1960. (Hammersmith Hospital, London, W.12, England)

The authors made a study of 32 patients suffering from various types of hemolytic anemia, using radioactive chromium to label the red blood cells. The role of the spleen and liver in erythrocyte destruction was assessed by an *in-vivo* surface-counting technic. Standard technics for red blood cell labeling were employed. Erythrocyte survival curves were plotted in hereditary spherocytosis, hereditary elliptocytosis, hereditary nonspherocytic anemia, sickle-cell disease, paroxysmal nocturnal hemoglobinuria, and auto-immune acquired hemolytic anemia of warm- and cold-antibody types.

In hereditary spherocytosis and elliptocytosis, the erythrocytes were eliminated from the circulation at an approximately steady increased rate; the data plotted on arithmetical graph paper gave rise to a slightly curvilinear graph. In sickle-cell anemia, in hereditary nonspherocytic anemia, and in paroxysmal nocturnal hemoglobinuria, the cell-survival graph appeared to have two components, suggesting the presence of erythrocytes varying widely in their life span.

In acquired hemolytic anemia of the warm-antibody type the data were consistent with random (exponential) elimination. In the cold-antibody type erythrocyte survival was only moderately reduced or almost normal.

An analysis of surface-counting data showed the existence of four patterns of Cr^{51} accumulation: (1) excess accumulation in the spleen; (2) excess accumulation in the liver; (3) no excess accumulation in liver or spleen; (4) excess accumulation in both liver and spleen. Patients showing the first pattern will in all probability benefit from splenectomy; in those with patterns 2 and 3, splenectomy would probably fail. With the fourth pattern, only limited benefit could be expected.

Fifteen figures; 4 tables.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Anemia of Hepatic Disease Studied with Radiochromium. Madison J. Cawein, III, Albert B. Hagedorn, and Charles A. Owen, Jr. Gastroenterology **38:** 324–331, March 1960 (Mayo Clinic, Rochester, Minn.)

Survival of circulating erythrocytes was measured by the radiochromium technic in 32 patients with disease of the liver: 22 had cirrhosis, 6 had hepatitis, and 4 had malignant tumors of the liver or biliary system. Chromate Cr^{51} was added to whole blood in a dextrose-

citrate anticoagulant. After fifteen minutes, an aliquot of the mixture was returned to the patient intravenously. Most of the Cr^{51} not bound to the red cells disappeared from the patient's plasma in twenty-four hours, so that after this time essentially all of the radioactivity of the whole blood was in the cells. Samples of heparinized whole blood were collected every other day during a two-week period, and the Cr^{51} activity assayed in a sodium iodide (thallium-activated) well counter. *In vitro* studies showed that the correction factor for "elution" of Cr^{51} from normal cells at the rate of 1 per cent per day is probably also applicable to erythrocytes in patients with cirrhosis. Gastrointestinal hemorrhage was quantitated by comparing the Cr^{51} in stool specimens with the Cr^{51} in the circulating blood.

Only 4 of the 32 patients with hepatic disease had erythrocyte survival times within the normal range, that is, Cr^{51} half-times greater than twenty-five days. Since in only 4 patients was there significant bleeding from the alimentary tract, the major cause of the diminished survival rates appears to be a hemolytic process. This view is supported by the inverse correlation found between the survival rates and the levels of total bilirubin in the serum. Evaluation of marrow activity from a correlation of the hematocrit reading and the red cell survival values warrants the conclusion that regenerative activity of erythropoietic tissues was considerably less than maximum. No direct evidence for a maturation arrest of erythropoiesis was obtained.

Two figures; 7 tables. GARTH R. DREWRY, M.D.
Tampa, Fla.

Behavior in the Circulation of the Radioactive Pulmonary Embolus and Its Application to the Study of Fibrinolytic Enzymes. Michael Hume, W. L. Glenn, and Therese Grillo. Ann. Surg. **151:** 507–516, April 1960. (Yale University School of Medicine, New Haven, Conn.)

The present distressing lack of objective criteria by which thromboembolic disease can be described seriously hampers an evaluation of fibrinolytic enzymes based on clinical observation. An experimental method of evaluation consequently assumes greater importance in this field. The authors outline a procedure for observing the fate of radioactive emboli in animals by external counting and by measuring the radioactivity of blood and urine samples. The preparation and introduction of the clots are described in detail. Chromium 51 was used to tag erythrocytes in the study of the rate of disappearance of clots because its half-life is longer than that of iodine.

Observation of the radioactive embolus confirms previous demonstration of spontaneous clot lysis and supplies additional information on the rate of clot removal. There is also suggestive evidence that new thrombus may be deposited even as the mass of the experimental clot is being reduced in the circulation. Weighing the clot permits a more precise estimate of the rate of change in clot mass and has aided in the evaluation of several details which bear upon the stability of the clot in the circulation. A prolonged decline in the activity over the thorax was the single most reliable evidence of clot lysis. The fibrinolytic action of plasma, as well as of streptokinase, was studied. Changes in urine radioactivity can be related to other parameters demonstrating clot lysis.

Six charts; 1 table. JOHN P FOTOPOULOS, M.D.
Northwestern University Medical School

Transfer of $Zinc^{65}$ Across the Placenta and Fetal Membranes of the Rabbit. Carolyn W. Terry, Boyd E. Terry, and Jack Davies. Am. J. Physiol. **198:** 303–308, February 1960. (Washington University Medical School, St. Louis, Mo.)

The distribution of radioactivity in the rabbit fetus and placental structures (fetal placenta, decidua, yolk sac) was studied at different stages of gestation following the intravenous injection of Zn^{65} into the mother. The uptake of radiozinc by the products of conception increased with advancing gestation but never exceeded 8 per cent of the total dose given. The recovery rose sharply between the twentieth and twenty-second day, suggesting the maturation of a fetal acceptor organ or an increased efficiency of the placental transport mechanism. Evidence is presented that the fetal liver is mainly responsible for the increased fetal recovery in the later stages of pregnancy. In addition, the placental recovery of radioactivity following the removal of the fetuses is equal to that obtained from the combined fetuses and placentae in the control side of the uterus; this suggests that the removal of radiozinc from the maternal blood is not dependent on a fetal acceptor. The transfer of radiozinc from the maternal blood is almost entirely *via* the fetal placenta. The yolk sac plays an insignificant part in both the storage and transport of the metal. Retrograde transfer from the fetus to the mother has also been demonstrated.

Three graphs; 3 tables. AUTHORS' SUMMARY

The Employment of Ion-Exchange Resins for the Removal of Plutonium from the Gastrointestinal Tract. Y. A. Belyaev. M. Radiol., Moscow **5:** 44–47, March 1960. (In Russian)

The author studied the effect of some ion-exchange resins relative to the removal of Pu^{239} from the gastrointestinal tract. Experiments, conducted on rats, with $Pu(NO_3)_4$ or plutonium citrate introduced perorally disclosed that the ion-exchange resins under study (KU-Z, EDE- 10, AN-2F) reduce by several times the content of plutonium in treated rats. Their efficacy decreases with the lengthening of the time between the administration of plutonium and the introduction of ion-exchange resins, due to the rapidity of plutonium resorption from the gastrointestinal tract.

One table. AUTHOR'S ABSTRACT

RADIATION EFFECTS

Irradiation Pneumonitis in the Treatment of Carcinoma of the Breast. M. N. Lougheed and G. H. Maguire. J. Canad. A. Radiologists **11:** 1–10, March 1960. (Montreal General Hospital, Montreal, Quebec, Canada)

From 1953 to 1957 inclusive, 491 new cases of breast cancer were seen at the Montreal General Hospital. Two hundred and fifty-five of these patients received radiotherapy: in 94 cases quadrate fields were employed; in 91 postoperative irradiation was delivered to immediate areas of lymphatic drainage; in the remaining 70 cases irradiation was given for metastases to other areas. Chest roentgenograms were taken routinely on all patients before, during, and after treatment; few had

signs or symptoms referable to the respiratory tract.

Sixty-nine of the 94 patients receiving large field, *en bloc*, quadrate radiotherapy to the intact breast, axilla, chest wall, and anterior mediastinal lymph nodes, had sufficient follow-up for analysis. In 42 of the 69 (61 per cent) abnormalities were demonstrated roentgenographically which could be attributed solely to the irradiation. The average dose to patients receiving quadrate therapy resulting in lung changes was approximately 6,500–7,000 r in ten to eleven weeks, and a large area of the lung was irradiated. Acute radiation pneumonitis developed in 4 patients who had received total lung doses of 6,000 to 8,800 r; there was a dramatic response to cortisone and ACTH in these cases, but roentgen examination failed to show evidence of improvement.

Of 91 patients receiving postoperative irradiation, 46 had sufficient follow-up for analysis; 17 of these (37 per cent) showed changes in the chest roentgenogram attributable to irradiation. The average radiation dose was approximately 6,500 r in seven weeks to a relatively small portion of upper lobe. The changes were much less extensive and less marked in this group.

The average dose to patients with radiation changes in the lungs demonstrated roentgenographically was significantly higher than the average dose in those whose lungs remained normal. There was, however, no statistical difference in the doses resulting in minimal, moderate, or marked lung changes, respectively.

The absence of basal pleural effusion in this series of patients is noteworthy.

The lung changes tended to appear within the first two to three months following irradiation. Spontaneous resolution of the lung changes did occur, but it was seen in only a small proportion of cases and was incomplete.

Eight roentgenograms; 3 tables.

CAPT. ROBERT E. WILDIN, M.C.
Lackland AFB, Texas

Radiation Reaction in the Lung. Report of a Fatal Case in a Patient with Carcinoma of the Lung, with Studies of Pulmonary Function Before and During Prednisone Therapy. Theodore Rodman, Samuel Karr, and Henry P. Close. New England J. Med. **262:** 431–434, March 3, 1960. (VA Hospital, Philadelphia, Penna.)

The authors report a fatal case of radiation reaction in the lung following rotational therapy (250 kv; tumor dose 5,000 r) for an anaplastic bronchogenic carcinoma, located in the upper mediastinum. Approximately two months and a half after completion of the irradiation, the patient was admitted to the hospital, complaining of severe dyspnea. Extensive pulmonary function studies were carried out at this time and after three weeks of treatment with prednisone (10 mg. four times daily). These studies suggested lung restriction and localized the process physiologically to the area of the alveolar-capillary membrane, with the formation of a block to the diffusion of oxygen from the alveoli into the pulmonary capillary blood. Such changes are consistent with the morphological picture in radiation reaction in the lung.

Remarkable subjective improvement followed immediately upon treatment with prednisone, but this improvement was not reflected in the pulmonary function studies, which were interpreted as indicating slight progression of the physiologic derangement. The patient's condition subsequently deteriorated, and he died about six weeks after admission. Autopsy disclosed extensive tumor invasion of the abdomen, including the subdiaphragmatic periaortic lymph nodes. Microscopic examination showed dense fibrous-tissue infiltration of the lungs and a small residual tumor.

In this patient a portal 15 cm. wide was used. The authors believe that rotational x-ray therapy should be employed only when the lesion to be irradiated can be encompassed with a narrow portal, 6 cm. in width or less. They conclude that adrenocorticosteroids do not alter the progress of a radiation reaction, although subjective symptoms may be ameliorated.

Three roentgenograms; 1 photomicrograph; 3 tables.

HAROLD A. SWANSON, M.D.
Calgary General Hospital, Calgary, Alta.

Alteration in Glucose Tolerance Produced by Irradiation of the Pelvis. Lilia Lopez Borja, John B. Graham, and J. E. Dowd. Acta radiol. **53:** 300–304, April 1960. (Roswell Park Memorial Institute, Buffalo, N. Y.)

Glucose tolerance studies were undertaken in a group of 27 patients with primary cancer of the uterine cervix. These patients received a course of roentgen therapy for a cervical dose of 5,700 r in five weeks, followed by 2,000 to 3,000 r to point A from a radium applicator. Oral and intravenous glucose tolerance and insulin tolerance tests were performed before and near the end of treatment. Although there was some individual variation, in general there was an increased tolerance for glucose given orally and a diminished tolerance to glucose given intravenously at the end of radiotherapy, as compared to pretherapy values. The authors suggest that the change in oral glucose tolerance during pelvic irradiation is related to an impairment of absorption and that the alteration in intravenous glucose tolerance is related to impairment of utilization. The insulin tolerance is not significantly altered by irradiation. There was a return to normal in all three tests several months after completion of radiotherapy.

One diagram; 1 table.

BYRON G. BRODGON, M.D.
University of Florida, Gainesville, Fla.

Roentgenological Bone Findings After High-Voltage Injury. J. Kolář and R. Vrabec. Fortschr. a. d. Geb. d. Röntgenstrahlen **92:** 385–394, April 1960. (In German) (Karls-Universität, Prague, Czechoslovakia)

Body contact with high-tension electric currents may generate a temperature of 2,500 to 3,000° C., thereby causing serious heat damage to soft tissues, and even to underlying bones. The authors have observed osseous lesions in more than 150 cases.

Bone and joint changes are caused either by muscle spasm or by the electric current itself. Muscle spasm will result in nonspecific fractures and dislocations. The electric current is responsible for an easily missed "osteoschisis," which is a thin fissure of interrupted continuity, best seen in long bones.

Healing of damaged bones is usually prompt, but secondary cyst formation and sclerotic bone reactions may be detected many years after injury. Other late changes are osseous necrosis with spontaneous sequestration, osteochondritis dissecans, periosteal calcification, and acro-osteolysis of the distal phalanges. When joints are affected, the healing process tends to terminate in bony ankylosis with flexion deformity. Epiphyseal involvement of growing bones will result in localized growth arrest.

Many cases were followed for years and even decades, and the authors emphasize the importance of periodic re-examinations of bones subsequent to electric trauma. The specific findings are well illustrated.

Eighteen roentgenograms. ERNEST KRAFT, M.D.
Northport, N. Y.

Leukemia in Hiroshima Atomic Bomb Survivors. Robert Heyssel, A. Bertrand Brill, Lowell A. Woodbury, Edwin T. Nishimura, Tarunendu Ghose, Takashi Hoshino, and Mitsuru Yamasaki. Blood **15:** 313–331, March 1960. (R. H., Vanderbilt University School of Medicine, Nashville, Tenn.)

Sufficient time has elapsed since the bombing of Hiroshima and Nagasaki (in 1945) that it is now possible to present an analysis of the incidence of leukemia following radiation based on fixed samples of survivors. The authors summarize the findings observed in the Hiroshima survivors from 1945 to 1958.

The incidence of leukemia was higher among those closely exposed to the radiation than among those remote from the hypocenter. Survivors exposed at less than 1,000 meters received heavy irradiation, while persons exposed at distances greater than 2,000 meters received a negligible dose. Estimates of the incidence of leukemia in the most distant group are in excellent agreement with recent estimates of leukemia incidence for the Japanese population as a whole. Signs of severe acute radiation damage are not necessary for the subsequent development of radiation-induced leukemia.

Increased incidence of leukemia in the survivors of the bombing first became manifest three years following exposure. The incidence reached its peak between the years 1950 and 1952, and since that time has been diminishing. But thirteen years after exposure, it is still higher than would be expected in the general population. The chronic granulocytic variety of leukemia has shown the greatest increased incidence. No apparent difference in the natural history of the specific types of leukemia in exposed and nonexposed Japanese has been demonstrated.

Preliminary analyses of the authors' data show a linear relation between the dose of radiation and the incidence of leukemia above 50 to 100 rad. Below this dose, the shape of the curve is not certain.

Seven graphs; 8 tables.

GERALD J. KURLANDER, M.D.
Indiana University Medical Center

Single Dosage X-Ray Radiation to the Lung and Posterior Mediastinum Through the Open Chest. II. Results in Animals Receiving a Dose of 5,000 r. John J. Fomon, Frank T. Kurzweg, and Harold Davis. J. Thoracic & Cardiovas. Surg. **38:** 553–558, October 1959. (University of Miami School of Medicine, Miami, Fla.)

Cliffton, Henschke, and Selby (Cancer **11:** 9, 1958. Abst. in Radiology **71:** 625, 1958) have recorded their experience with the treatment of cancer of the lung by interstitial implantation at the time of thoracotomy. Chesney and Daughtry (unpublished data) have irradiated the lung through the open chest at the time of exploration for bronchogenic carcinoma. Because of the limited experience with the latter method, the authors undertook a laboratory study and in 1958 published their results in animals receiving doses between 6,000 and 15,000 r (J. Thoracic Surg **35:** 771, 1958. Abst. in Radiology **72:** 800, 1959). A second series of dogs given doses of 5,000 r has now been observed. The method employed was essentially as previously described. The animals were divided into three groups, and thoracotomies were performed on all. Group I received 5,000 r through a portal of 25.2 sq. cm. directly to the lung. A similar dose was given in Group III but the field was 102.1 sq. cm. In Group II, the irradiation was delivered to the posterior mediastinum only, with the lung protected.

Almost all animals died as a direct result of the irradiation. When there was necrosis of the trachea, the process often involved the lung, with erosion of one of the pulmonary vessels. In these instances, a fatal hemoptysis occurred. Usually, when the esophagus was perforated, there was not a free communication into the pleural space but penetration into the posterior mediastinum. Significant statistical difference in survival times existed only between Groups I and III. No relationship between surface area of the dog and area irradiated could be demonstrated. Additional work must be done to establish the safe maximum dose of x-rays that can be tolerated by this method.

Five figures; 1 table.

Radiation-Induced Gastrointestinal Death in the Monkey. Stephen G. Wilson, Jr. Am. J. Path. **35:** 1233–1251, November-December 1959. (Radiobiological Laboratory, University of Texas, Austin, Texas)

This report is concerned with the unique changes produced in the gastrointestinal tract of *Macaca mulatta* monkeys by supralethal doses of gamma radiation and includes a discussion of some of the inferences which may be drawn with respect to the pathogenesis of the observed intestinal ulcers.

Ninety-nine monkeys were divided into groups of 5 to 8 animals each and then irradiated with doses ranging from 400 to 40,000 r. The radiation facility consisted of 32 Co^{60} sources rated at 237 curies each, distributed uniformly over a spherical wire frame 36 inches in diameter. The dose rate in the exposure chamber centered in the sphere was 803 r per minute. A previous paper presented the pathologic features in 20 monkeys dying a "central nervous system death" (U.S.A.F. Report No. 59-58, 1959); with two exceptions these animals had received 10 kiloroentgens or more.

Forty-four monkeys irradiated with 1,500 to 7,500 r died between four and nine days afterward, with the greatest percentage of deaths occurring on the sixth, seventh, and eighth days. The mean survival time was six days. The most prominent findings at necropsy were gastric and colonic ulceration. Colonic ulceration was found in 33 of the animals, and its incidence was invariant with radiation dosage over the dose range tested. Gastric ulceration was noted only thirteen times; its incidence increased as radiation dose increased. Evidence presented suggests that bacteria play a dominant role in the production of gastric and colonic ulceration following supralethal irradiation.

Severe mucosal atrophy occurred in both the small intestine and the colon. It could be divided into four basic types which reflected the severity of cytologic distortion of the epithelial cells and the degree of epithelial regeneration. In the small intestine, the distribution of the lesion types was a function of radiation dose; in the colon the distribution was a function of survival time. The significance of these variations is discussed.

Fifteen illustrations; 1 table.

Changes in the Cerebral Circulation of an Animal After Whole-Body Ionizing Irradiation. R. M. Lyubimova-Gerasimova. M. Radiol., Moscow **5:** 24–29, April 1960. (In Russian)

A study was made of the vascular changes in the animal brain produced by a single radiation dose of 1,000 r. Serial angiography and photography of pial vessels via cranially implanted Plexiglas ports showed that clearly pronounced disturbances are identifiable with each stage of radiation illness. About two hours after irradiation, vascular spasm results in a diminished blood flow. The vessels then begin to relax, and by twenty-four hours venous dilatation is observed. Thereafter the vessels appear normal for a few days and then contract, so that one or two days before the animal's death the blood flow is so diminished as to produce cerebral anemia.

FRANK A. RIEBEL, M.D.
Columbus, Ohio

Failure of AET to Protect Against Testes Injury in the X-Irradiated Rat. B. H. Ershoff and V. Brat. Am. J. Physiol. **198:** 655–656, March 1960. (Western Biological Laboratories, Culver City, Calif.)

Intraperitoneal administration of AET (S, 2-aminoethylisothiuronium.Br.Hbr) at a level of 300 mg./kg. body weight was found to prevent death but not testicular injury in rats exposed to a single lethal dose of total-body x-irradiation. Whereas all rats exposed to 900 r but not given AET succumbed within the three-week period following irradiation, 60 per cent of the rats receiving AET were still alive sixty days after irradiation. Histologic examination of testes of rats given AET and subsequently exposed to irradiation revealed extensive injury and depletion of the cellular elements of the seminiferous epithelium similar to findings previously reported as characteristic for radiation injury.

Two photomicrographs.

Quantitative Studies of Bone-Marrow Cells in the Early Stages of Final Haemopoietic Recovery in Irradiated Guinea-Pigs. P. F. Harris. Brit. J. Haematol. 6: 107–121, April 1960. (University of Sheffield, England)

The purpose of this paper is to indicate the cells which are most conspicuous in the early stages of the final recovery of hemopoiesis in the bone marrow of young guinea-pigs recovering from a single dose (150–170 r) of whole-body gamma radiation from a Co^{60} unit. The findings are based upon quantitative examinations of bone-marrow cells at frequent intervals after irradiation until hemopoiesis appeared to be completely restored. Studies were made of 144 animals.

Three phases were evident in the irradiated marrow. The first phase was of damage produced by irradiation, with a considerable reduction in the number of nucleated cells and an increase in the number of mature red cells. In the second or intermediate phase regeneration began. However, fourteen days after irradiation and before regeneration of granulocytes and erythroid cells, the marrow had a very characteristic appearance. At this time there was a marked neutropenia and three types of cells seemed to predominate: (1) small round cells resembling small lymphocytes in smears of lymphoid tissue; (2) cells intermediate in appearance between lymphocytes and blast cells; (3) fat cells. Morphologically there was evidence of transitions between lymphocytes and the intermediate cells and between the latter and blast cells. Certain findings suggest that the intermediate cells might be considered as early free stem cells: (1) their numerical relation to blast cells in normal marrow; (2) their marked radiosensitivity; (3) mitotic figures seen in cells of their shape, size, and cytoplasmic content; (4) considerable number of these cells preceding and accompanying rapid regeneration of myeloblasts and proerythroblasts.

The fat cells did not increase during the initial stage of marrow damage, when the decrease in nucleated cells was most marked, but did increase during the intermediate phase when there was hemopoietic regeneration. These experiments suggest that the function of marrow fat cells may be more than merely a space-filling mechanism. In the final phase, when regeneration was complete and the marrow contained large numbers of mature granulocytes and erythroid cells, fat cells and round cells were greatly decreased in number.

While the nomenclature of cells in guinea-pig bone marrow is slightly different from that for cells in man, it is sufficiently close that extrapolation is easily done.

Twelve figures. SYDNEY F. THOMAS, M.D.
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Red Cell Repopulation in Irradiated Mice Treated with Plethoric Homologous Bone Marrow. Joan Wright Goodman and Ray D. Owen. Am. J. Physiol. **198:** 309–314, February 1960. (Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

Marrow from normal homologous donors injected into heavily irradiated (950 r of 250-kv x-rays, at a rate of approximately 170 r/min.) mice results in rapid and permanent replacement of host- by homologous donor-type erythrocytes. Plethoric marrow, produced by artificial polycythemia, was capable of red cell repopulation of an irradiated homologous host. Repopulation was slower than when normal marrow was used but reached 100 per cent donor type and remained permanently at that level in all chimeras tested. There was a large decrease in hematocrit within the first two weeks after irradiation and bone-marrow treatment in some, but not all, homologous combinations tested. In the combination studied most extensively, lethally irradiated $(C_3H \times 101)F_1$ animals receiving $(C_{57}L \times A)F_1$ marrow, the early anemia was considerably ameliorated by the use of plethoric in place of normal marrow. Possible mechanisms for these effects are discussed. It is suggested that plethoric marrow has a potential greater than that of normal marrow for producing blood platelets and can rapidly effect repair of capillary walls and thus reduce early red cell loss.

Two graphs; 2 tables.

In Vitro Leucine Incorporation into Protein of Normal and X-Irradiated Rabbit Bone Marrow Cells. Edwin M. Uyeki, Harvey Key, and Paul R. Salerno. Am. J. Physiol. **198:** 652–654, March 1960. (Western Reserve University School of Medicine, Cleveland, Ohio)

When compared with nonirradiated controls, the isolated bone-marrow cells of x-irradiated rabbits showed a decrease (*c.* 40 per cent) in the *in vitro* uptake of labeled leucine into proteins one and two days after exposure to 400 r and 800 r. Inhibition of leucine incorporation of similar magnitude was observed in hemibody x-irradiated rabbits in which the marrow cells from the irradiated femur were compared with those from the nonirradiated side. The decreased uptake of leucine

into protein after irradiation may be due to an interruption in the supply of young forms during the post-irradiation period; the decreased uptake of amino acids into proteins, therefore, may be characteristic of the mature cells of the surviving cellular elements.

One graph; 1 table.

The Effect of Whole-Body Radiation and Infection on Arterial Replacement. Richard W. Hardy, Luis A. Perales, Geoffrey A. Boughton, Erving F. Geever, Roger T. Sherman, and William H. Moncrief, Jr. Ann. Surg. **151:** 359–366, March 1960. (Walter Reed Army Institute of Research, Washington, D. C.)

Considering the recent rapid expansion of the field of vascular surgery, an experimental evaluation of the treatment of acute arterial injuries was designed to investigate the following problems: (1) the fate and long-term results of vein grafts used for replacement of peripheral arterial segments; (2) the effect of infection on the implantation of vein grafts, homografts, and plastic arterial prostheses; (3) the fate of arterial grafting for traumatic arterial injury with associated total-body ionizing irradiation.

Autogenous vein grafts were employed in 34 dogs and Dacron-Teflon arterial prostheses in 50. The femoral, carotid, and iliac arteries were used for the grafting procedures. The animals were divided into three groups. Group A: *Control.* In 10 dogs, 10 autogenous vein grafts were inserted in femoral arterial defects; in 16 dogs, 24 plastic arterial prostheses were utilized. Group B: *Whole-Body Ionizing Radiation.* Autogenous vein grafts and plastic prostheses were used in a total of 35 dogs. Four to twenty-eight hours prior to operation, the animals were given 300 r total-body radiation (from a high-intensity cobalt source). Group C: *Whole-Body Ionizing Radiation Plus Induced Infection.* Twelve autogenous vein grafts and 26 plastic prostheses were utilized in 23 dogs. In addition to total-body irradiation as in Group B, the dogs received, at the time of operation, an injection into the peritoneum of 3 ml. of a mixed bacterial culture containing *Staphylococcus aureus, Streptococcus fecalis, Escherichia coli,* and *Clostridium perfringens* in concentration of 10^8 bacteria per milliliter.

It was found that the vein grafts did not remain viable. There was failure to retain original architecture in the autogenous grafts with degeneration and replacement by an ingrowth of fibrous tissue. This resulted in the reduction in the capacity of the venous autograft to carry arterial pressures. Dilatation is prone to follow with the possible sequelae of rupture or thrombosis. Plastic arterial prostheses are therefore preferable to vein grafts.

The sublethal whole-body irradiation produced no significant effect on the ultimate outcome of either vein grafts or plastic arterial prosthesis in the dogs studied. It is surmised that ionizing radiation received at the time of wounding will not significantly affect the healing of arterial injuries, a conclusion which is in keeping with the effects of sublethal radiation at the time of wounding or wound healing in other systems. The investigation also showed that infection did not significantly affect the fate of vein grafts or of arterial prostheses. It is emphasized that inferences concerning the effect of bacterial contamination on arterial grafting in man should not be made on the basis of this study.

The authors conclude that the use of autogenous vein grafts and plastic arterial prosthesis is not contraindicated in wounding with concomitant sublethal radiation. They may be employed in contaminated wounds if thorough débridement and active treatment of infection is carried out. The long-term fate of vein grafts is such that they are not the arterial replacement of choice, but they may be used when suitable plastic prosthetic material is not available.

Two roentgenograms; 5 photomicrographs; 6 charts.

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Relation of Hepatic Ketogenesis to Radiation-Induced Decrease in Fasting Ketonemia. Joseph A. Ontko. Am. J. Physiol. **198:** 33–36, January 1960. (School of Aviation Medicine, Randolph Air Force Base, Texas)

The studies reported here were undertaken to supply information on radiation-induced alterations in the liver with particular emphasis on fatty acid oxidation.

Male weanling rats were exposed to 500 r of whole-body x-irradiation and then fasted. Control rats were concurrently fasted. Ketonemia, ketonuria, hepatic glycogen, ketogenesis by liver slices, and fatty acid oxidase activity of liver mitochondria were measured. A radiation-induced decrease in fasting ketonemia was observed; this decrease was mainly in the β-hydroxybutyric acid fraction. Ketonuria was similar in both control and irradiated animals the first post-irradiation day and lower in the irradiated group during the second day. Decreased ketonemia in the irradiated rats, which exhibited diuresis, was thus apparently not due to increased urinary excretion of ketone bodies. Ketogenesis by liver slices from irradiated rats was depressed. This indicated that an antiketogenic process contributed to the radiation-induced decrease in fasting ketonemia. Fatty acid oxidase activity of liver mitochondria isolated from control and irradiated animals was similar. Thus, rate-limiting fatty acid oxidizing enzymes were not altered by irradiation under these conditions. This illustrates an apparent modifying effect of other cellular fractions on fatty acid oxidation in mitochondria.

One graph; 3 tables. AUTHORS' SUMMARY

Radiation: Registration of Sources. Dell F. Dullum. California Med. **92:** 198–200, March 1960. (California State Department of Public Health, Berkeley 4, Calif.)

Registration of sources of ionizing radiation, including x-ray machines and radioactive material employed in the healing professions, is required by recent legislation in California. Such registration is designed to furnish information concerning the type and location of radiation sources and provide a basis for the evaluation of the need of additional controls and protection in the future.

The medical uses of radiation procedures constitute a major portion of the exposure to the total population. Useful and effective methods to minimize patient exposure, based on professional knowledge, competence, and experience, with profession-wide participation and support, will insure the effective integration of medical radiation in the California Atomic Energy Development and Radiation Protection Program.

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